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THE DIFFICULITES FACED BY SOME TEACHERS WITH STRONG RELIGIOUS BELIEFS WHEN THEY TEACH EVOLUTION

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A research report submitted to the Faculty of Education, University of the Witwatersrand, Johannesburg, in partial fulfilment of the requirements for the degree of Master of Education

Johannesburg, 2011

ABSTRACT

In 2008, the topic of “evolution” was introduced into the Life Science syllabus for the first time in South African schools. Evolution is a controversial topic in most countries and the controversy will be experienced in South African schools. This controversy results from the erroneous belief that teachers and most people have that religion and evolutionary theory contradict each other.

This research study explored the difficulties faced by teachers with strong religious beliefs when they teach evolution. Eight teachers with strong religious beliefs were identified. Teachers of the Muslim and Christian faith who taught at either religious or secular schools formed part of the research study. The teachers were subjected to an in-depth interview where they were questioned about their religious beliefs and their opinions about creation and evolution. They also described how they taught evolution and explained how they coped with the conflict of faith and science that they experienced when they taught evolution. These teachers also experienced myriad difficulties when they taught evolution. These difficulties were described to me as the researcher.

The findings indicated that all of the Muslim teachers and three of the four Christian teachers interviewed are Creationists. This leads to personal conflict that some of the teachers interviewed experience because of their belief that evolution and religious belief contradict each other. Two of the teachers in this study also experience a lack of confidence with the subject knowledge because they lack training in evolutionary theory. Due to this lack of training there are some teachers who harbour misconceptions about evolutionary concepts and who pass these misconceptions to learners. There is also pressure placed on teachers to teach creationism or to teach creationism alongside evolution from some religious leaders, some parents and certain members of the community. A few teachers with strong religious beliefs could teach evolution very superficially or these teachers could even sabotage their teaching of evolution.

Teachers also experience difficulties teaching the learners in their class. The findings indicate that learners in religious schools may refuse to learn about evolution and learners in certainschools choosenot to do Life Sciences from Grade 10 to avoid learning about evolution. There are certain strategies that teachers employ to minimise the conflict they experience when teaching evolution. Learners were told they had to study evolution in order to pass the matriculation examination. Teachers also explained to learners that they needed to study evolution so that they could argue for Creationism from a position of knowledge and not ignorance. Certain teachers interviewed taught learners that science needs to be considered separate to religion. The conflict of faith and science that teachers experience when they teach evolution causes difficulties for these teachers.This conflict could arise from personal conflict with their faith or they could experience discord from learners, parents and members from the community in which they teach.

KEYWORDS

Creation

Teaching of evolution

Religious beliefs

DECLARATION

I declare that this report is my own work. It is being submitted for the degree of Master of Education in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other university.

(Signature of candidate)

Date: 9 December 2011

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DEDICATION

To my husband, Anand: we embarked on this journey together and it’s been a thrilling ride.

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CHAPTER ONE

INTRODUCTION TO THE STUDY

1.1 Introduction

In 2008 a new topic was introduced for the first time to the Life Sciences curriculum for the Grade 12 learners in South Africa. This topic is “evolution” and the importance of this topic is reflected in the assessment since it comprises 25% of the Grade 12 curriculum (Department of Education, 2007a). A new content framework for the subject Life Sciences was launched with Grade 10 being taught in 2009, Grade 11 in 2010 and Grade 12 in 2011. This new framework now introduces “evolution” to Grade 10 learners with the remainder of the topic being taught in Grade 11 and Grade 12. Evolution of humans is taught in Grade 12. The response to an article in the Naptosa newsletter, *Insight* (Venter, 2008) on the introduction of the teaching of “evolution” reflected a gamut of responses. These responses ranged from enthusiasm that evolution is to be taught to outrage that the teaching of “evolution” infringes on the religious beliefs of learners.

1.2 Background to the study

Curriculum 2005 was introduced in 1997 into the General Education and Training band (GET) in South African schools. The curriculum was revised and republished as the National Curriculum Statement (NCS) (Chisholm, 2005). In 2001 the draft of the Revised National Curriculum Statement for grades R-9 of the GET band was made available for public comment. The Natural Sciences NCS stirred up some controversy since natural selection was included in the syllabus. The creation–evolution debate was never raised in school biology before 1994 in South Africa, because education policy ignored evolution due to the fact that it clashed with the religious beliefs of the then government. Christian National Education (CNE) which formed the basis for national education was based on racial segregation and based on Calvinism (Lever, 2002; Dempster& Hugo, 2006).

The NCS curriculum prompted varied responses from diverse religious groups. Chisholm (2002) reported that a certain group of Muslim schools welcomed the values expressed in the curriculum and observed that the curriculum acknowledged that certain problems cannot be solved by science. This provided for the teaching of creation as revealed truth as opposed to evolutionary theory proposed by some scientists. Also stemming from the response were further comments that “evolution” is “unChristian", an “unproven theory”, “contrary to the Biblical account of creation”, “racist” and an infringement of parental rights. In 2003 the National Curriculum Statement (NCS) for the Life Sciences for the Further

Education and Training band (FET) was published. The NCS for the Life Sciences included the teaching of “evolution” in the content area “Diversity, change and continuity”. “Evolution” was taught to Grade 12 learners for the first time in 2008 (Department of Education, 2003).

1.3 The research problem

The motivation behind this research grew out of distinct personal and professional experiences. I have been teaching Life Sciences or Biology as the subject was previously known as for the past 12 years. I have also served as the Head of the Life Science Department in my school for the past five years. In my capacity as Head of the Life Science Department, I have attended various meetings with other teachers together with the Life Sciences facilitator to discuss the assessment and teaching of Life Sciences. During these meetings some teachers have raised the issue of the difficulties they face when teaching “evolution”. One of the teachers said that the Principal of the school was astounded by what he taught on “evolution” and said it was “unchristian,” whilst another teacher said that she couldn’t teach this section because it was against the Bible and her own personal beliefs.

When, as the Head of the Department in my school, I started teaching this section, other teachers in the school suggested to learners that were in my class that they present a DVD to me advocating Creationism. Learners in my class also asked what religion I followed and were astounded that I am not an atheist. This ties in with the fact the evolution is often equated with atheism (Blackwell, Powell& Dukes 2003), and students often feel that they need to choose between religious convictions and the credibility of evolution (McKeachie, Lin & Strayer, 2002).

The perception by the general public is that evolution is confused with atheism (Miller, Scott &Okamuto, 2006)and that engaging in the learning of the topic would “challenge” the religious view of students (Chinsamy&Planganyi, 2007). Venter (2008) explains the science and faith debate by distinguishing between groups of belief systems. The group that have the theistic evolution persuasion believe that science and faith are complementary and that evolution is part of God’s plan. In particular Venter (2008) highlights those of the faith versus science persuasion who reject evolution because it contradicts sacred texts. This group of people will also question the scientific validity of evolution (the highlighted box in fig. 1). There are two main strands indicated, a group that has acknowledged the creator behind the creation of the universe, old earth creationists and the extreme group, the young earth creationists who take the literal creation as set out in Genesis 1 and 2 in the bible as scientific fact. This group will attack the scientific validity of evolution.

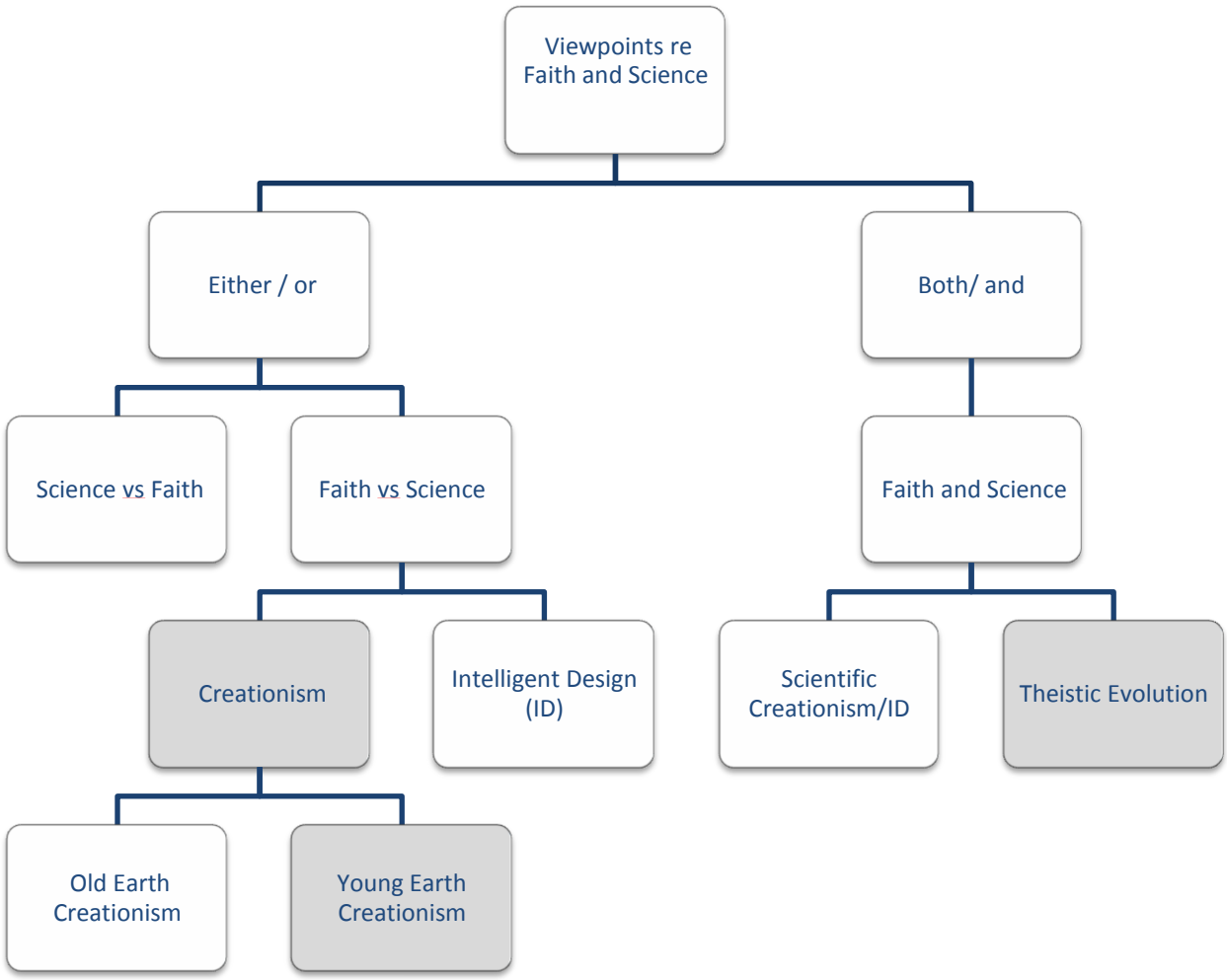


Figure 1: Viewpoints of faith and science

(Extracted from NAPTOSA insert)
(Venter, 2008)

According to Dempster and Hugo (2006) the teaching of evolution requires "highly specialized teachers" who already have a comprehensive knowledge of evolution to assemble the curriculum together in a coherent fashion, so that evolution clearly emerges as a fundamental principle. Ngxola and Sanders (2008) and Stears (2006) suggest that most teachers in South Africa lack training in evolutionary theory and do not understand its centrality in biology nor do they know how to teach evolution.

The problem that could arise when teachers with strong religious beliefs teach evolution could be that these teachers who teach evolution as part of the curriculum would emphasise to learners that they did not have to believe it (Stears, 2006).
Other problems could be that some teachers would:

- not teach evolution
- teach evolution superficially
- sabotage their teaching of the science when teaching evolution
- teach creationism and not evolution.
- experience difficulty when teaching learners whose prior knowledge about evolution is contrary to scientific knowledge (Verhey, 2005)

1.4 Aim of the study

The aim of this research is to gain insight into the teaching of evolution by selected teachers who have strong religious beliefs. Initially, my intention is to identify the difficulties faced by some teachers with strong religious beliefs when they teach “evolution”. Thereafter, I would need to ascertain how the strong religious beliefs of some teachers influence their teaching. And then, I will need to investigate the strategy that is used by some teachers to avoid the conflict between science and faith when teaching evolution.

Research questions

The following research questions will be answered during the study:

1. What viewpoints do teachers with strong religious beliefs have about creation and evolution?
2. How do teachers with strong religious beliefs teach evolution?
3. How do teachers manage the conflict of science and faith when teaching evolution?
4. What are the difficulties that are faced by teachers with strong religious beliefs when they teach evolution?

1.5 Delineating the study

The research study involved an investigation of selected Life Sciences teachers who have strong religious beliefs and who are teaching “evolution” to learners in South Africa. There were four Christian and four Muslim teachers that were interviewed since this was a small scale research study. Structured and semi-structured questions were asked during an in-depth interview with the teachers. Teachers were also asked to provide any lesson preparation that they had used when teaching “evolution”. Two of the Christian and two of the Muslim teachers taught at a religious school and the remaining teachers taught at secular schools.

1.6 Importance of the study

Evolution is the unifying concept when teaching Biology (Dobzhansky, 1973). Evolution explains biodiversity, accounts for the reason that certain organisms that look different to each other are related and provides an explanation for the appearance of humans on the earth and our biological connections to other organisms (National Academies of Sciences, 2008).

South Africa is abundant with natural resources that enhance the teaching of evolution (Dempster& Hugo, 2006). There are also many museums and national parks that facilitate the teaching and learning of evolution. Among them are Maropeng, where fossils of "Little Foot" and "Mrs Ples" were found and the West Coast fossil park where complete fossils of short-neck giraffes and other animals can be seen.

Ngxola and Sanders (2008) outline the difficulties teachers would face when teaching evolution. One of the difficulties is that textbooks pose a problem with the coverage of evolution. Teachers who are teaching evolution need to be aware of the potential challenges they may face when teaching biology (Chinsamy&Plaganyi, 2007). One of the potential challenges facing a teacher is that learners have a prior conception of evolution and this influences their learning (Blackwell,*et al.*, 2003; Abrie, 2010). In a study conducted over a period of twelve years, the percentage of Scottish students rejecting evolution declined from 11% to 4% (Downie& Barron, 2000). Downie and Barron suggest that this occurred due to the teaching that science advances with the testing of hypotheses. This leads to teaching the nature of science so that the word "theory" is not confused with the word guess but is understood in science to mean to "predict, explain and provide conceptual frameworks for further research" (Clough, 1994).

1.7 Sequence of the research report

The research questions which were the source of the research sought to identify the difficulties faced by Muslim and Christian teachers with strong religious beliefs when they teach evolution. In order to accomplish this I explored the beliefs of both Christians and Muslims concerning evolution. To achieve this, the creation-evolution continuum (Scott, 2000) was used as a framework to delineate the beliefs of Christians and Muslims. With both religions, I investigated categories proposed by Barbour (2000) that indicate the relationship that teachers could have between science and religion. These categories were used to outline and sort the personal beliefs of teachers and their scientific knowledge. Further, a model proposed by Meadows, Doster and Jackson (2000) was used to establish whether teachers avoid the conflict; are disturbed by the conflict or are managing the conflict.

The research report is divided into five chapters. Chapter one is the introduction which includes the research problem, the research questions, aim and importance of the study. This chapter provides the backdrop to the rationale that necessitated the study. Chapter two is the literature review that provides the framework for analysing the results of the research. Chapter three delineates the research design as qualitative and interpretative. The research study involved eight structured interviews which contributed to collective case studies of the respondents. In chapter four I report on the research findings from the interviews. The religious beliefs of the respondents were categorized. Thereafter, the relationship between science and religion of the teachers was identified. Next the categories of conflict their difficulties experienced by the teachers were ascertained. Then the strategies attempted by the teachers to avoid conflict were identified and described. The research data combined with the analytical framework made interpretation of the data possible. Chapter five includes the summary of the findings, suggestions for teaching evolution in the South African context and suggestions and recommendations for future research.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The teaching of evolution raises controversy in many countries. In 2002 there appeared to be a creation/evolution controversy in the United Kingdom where this controversy made headlines in the national press and on television (Williams, 2008). The controversy arose from the statement that a certain school was identified as teaching creationism (Williams, 2008). In a similar vein Wiles (2008) describes a "burning issue" where teachers in America "won't, don't or can't teach evolution properly". In the editorial of The American Biology Teacher, Wiles (2008) states that 12% of biology teachers in Oklahoma would rather teach creationism and not evolution. In a survey done by the National Science Teachers Association (NSTA) in the United States (NSTA, 2005), 30% of the teachers surveyed indicated that they felt coerced by their communities to overlook or downplay evolution and the related topics when teaching. A further 31% of teachers felt that they had to include alternatives to evolution in their teaching of evolution (NSTA, 2005).

The situation in South Africa is similar to that in the United States in that most of the community is against the teaching of evolution (Stears, 2006). The previous curriculum, influenced by Christian Nationalist Education, did not require evolution to be taught as a biological concept because it conflicted with the religious beliefs of the then government (Lever, 2002). The present curriculum requires that evolution be taught as a biological concept.

2.2 Why teach evolution?

About forty years ago geneticist Theodosius Dobzhanksy, a major contributor to the foundations of modern biology, wrote the now famous words that "nothing in biology makes sense, except in the light of evolution" (Dobzhansky, 1973: 125). At that time Dobzhansky was encouraging biology teachers to teach evolution to their pupils in spite of religiously motivated opposition. That statement is as valid now as it was then. I would argue that studying evolution is essential to gain an understanding of life on this planet. Essentially evolution explains biodiversity: illustrating that an abundance of different organisms inhabit the earth. It accounts for the fact that certain organisms that look different to each other are related and that other organisms that appear to look alike are only very distantly related. Evolution can provide an explanation for the appearance of humans on the earth and our

biological connections to other organisms. Evolution also explains how we humans acquired our traits and how groups of humans are related to one another. It is my contention that the teaching of evolution is thus an essential part of educating ourselves about who we are and why we are different and how, in understanding evolution, we can protect the different species that inhabit this planet.

2.3 The controversy of teaching evolution

Despite the obvious need for teaching evolution there is still much controversy in America, and Branch and Scott (2007) claim that science teachers are on the "front lines of the evolution wars" (Branch & Scott, 2007: 53). These wars according to Branch and Scott (2007) are being fought on two fronts, in the courtrooms and in classrooms. Thus, there is enormous pressure being placed on some teachers in some American classrooms to include "creation science" or "intelligent design" as alternatives to "evolution" (Branch & Scott, 2007; Clough, 1994; Sharpes & Peramas, 2006). Research done amongst certain groups of teachers in America indicate that there are some teachers whose lack of belief in evolutionary theory affected their teaching to the point that they taught evolution superficially or did not teach evolution at all (Aguillard, 1999; Rutledge & Warden, 2000; Trani, 2004; Wiles & Branch, 2008). In addition research done amongst students has indicated that some students have strong prejudices against evolution, often because of their religious beliefs (Blackwell,*et al.*, 2003; McKeachie,*et al.*, 2002). Research has indicated that the negative attitudes of students towards learning about "evolution" affects their willingness to learn and their learning success and a high proportion of students who do not believe in "evolution" drop out of evolution courses, or fail them, and are less interested or motivated to learn about "evolution"(McKeachie,*et al.*, 2002).

Miller,*et al.* (2006) found that US adults, who prayed regularly and believed in a personal God, were more likely to reject evolution. In their analysis of zoology students at South Eastern Louisiana University, Sinclair and Pendarvis (1997) found that the religious beliefs of students' interfered with their ability to be objective regarding scientific evidence. They also established that students who were very religious rejected evolution, and they felt that there was a dichotomy between religion and acceptance of evolution.

In the United Kingdom there is an increase in the number of Muslim learners in schools and this has impacted on the teaching of evolution (Ashrif, 1998). There is an increase in the number of learners that do not accept evolution in the United Kingdom and teaching evolution has become "increasingly difficult" (BBC news, 2007). Miller,*et al.* (2006) state that acceptance of evolution in Islamic countries like Indonesia, Pakistan, Egypt, Malaysia,

Turkey and Kazakhstan is 40 percent lower than in the United States of America. One of the reasons, provided by the authors for the lower acceptance of evolution in Islamic countries, is that evolution is aligned with atheism. Another reason given by Miller,*et al.* (2006)is that Biology is taught in a highly religious environment so much so that Biology textbooks in Pakistan contain Islamic verses from the Koran. Hameed (2008) refers to Adnan Oktar who has a website where books are available to download (harun-yaha.com). There is no specific reference in the Koran that opposes evolution but evolution presents more of a social and cultural threat than a religious threat (Hameed, 2008).

Dagher and BouJaoude (1997) quote Mayr (1982) who sees Darwin's theory as a composite of five theories:
"(a) the theory of a nonconstant and evolving world, (b) the theory of evolution by common descent, (c) the theory of gradual evolution, (d) the theory of populational speciation, and (e) the theory of natural selection." (Dagher & Saouma BouJaoude, 1997: 430)

Dagher and BouJaoude (1997) furnish quotes from the Koran where they compare the account of creation to that found in the Bible. The Koranic account of creation is a six-day event where Allah created all living things as they now are and that man is created from the "best of moulds". The concept of creation as a six-day event is further explained as a day being a thousand years and a thousand years being a day to the Creator (Hameed, 2008). The Muslim account of creation thus accedes to a constant unchanging world (a), but there is no notion of evolution (b and c). There is an acceptance of microevolution(d) and an acceptance of the theory of natural selection (e) with microevolution only (Dagher & BouJaoude, 1997).

2.4 **Teaching evolution in South Africa**

This controversy is bound to be just as contentious in South Africa. The National Curriculum Statement Grades 10-12 (General) claims that it is "sensitive to issues of diversity such as poverty, inequality, race, gender, language, age, disability and other factors" (Department of Education, 2003: 5). These other factors include teachers having to accommodate for cultural diversity in the classroom. Dimmockand Walker (2000: 46) define "culture" as "patterns of thinking, feeling and acting underpinning the collective programming of mind which distinguishes the members of one group or category of people from another". People with common religious beliefs form groups where they share these similar "patterns of thinking, feeling and acting". Thus religion can be considered as a culture. Sanders and Kasulu (2004) describe nine requirements for the teaching of outcomes-based lessons. One of these is that lessons comprise of meaningful learning experiences which are activity-

based and learner-centred. To teach a lesson that is learner-centred, teachers must be aware that learners in the classroom differ in terms of cultural backgrounds, beliefs and practices. For this to be successful teachers should plan lessons that are cognisant of these differences and teach to accommodate for these differences.

Chinsamy and Plaganyi (2007) argued that the problems facing students at a tertiary institution in South Africa when studying evolution are twofold. Firstly tertiary students who matriculated before 2011 have not been taught evolution at school. Secondly learners who have been taught evolution after 2011 may have been taught by teachers who don't understand the concepts of evolution well enough to teach it. These students then will perceive science to be incomprehensible and atheistic and will lack insight into the understanding of science and how science impacts on our lives.

Stears (2006) carried out research with a group of teachers registered for a module on Issues in Science Education, prior to evolution being taught in South Africa. The first group are teachers who believe that evolution should be taught as scientific fact without any reference to a belief system. The second group are teachers who believe that evolution is not in conflict with belief systems. The third group of teachers are those who would teach evolution as part of the curriculum but would emphasise to learners that they did not have to believe it. The fourth group of teachers are concerned about views of parents, learners and other members of the community and how they would react to "evolution" being taught in the classroom. The latter group of teachers were inclined to believe that the views of parents, learners and other members of the community could change with education. Ngxola and Sanders (2008) noted ten categories of comments relating to the concerns of teachers who have to teach evolution. The most common concern was lack of content knowledge with the second being the controversial nature of the topic of evolution. Teachers were concerned that evolution would contradict religious beliefs and confuse learners. The third concern involves the conflict between teachers' own religious beliefs and evolution. Ramsurwaj, Mokgobanama, Molefe, Maphisa, Masombuka and Doidge (2007) noted the views of Grade 11 Biology teachers and identified a group of teachers who hold antievolutionist views and believe that evolution is in conflict with their personal and religious beliefs. This group of teachers believe that evolution should not be taught to learners. In his study of student teachers in a South African university, Abrie (2010) found that many of them have religious views that are not in sync with the teaching of evolution and they were unwilling to teach evolution. He also noted that many of these student teachers have common misconceptions about evolution and demonstrated a lack of understanding of the nature of science.

2.5 **Beliefs of teachers**

I used the creation / evolution continuum (Scott, 2000) to categorise the belief systems of the teachers who participated in the study. According to the continuum the religious beliefs systems of teachers can be labelled. When the categories of teachers are identified from the creation / evolution continuum (Scott, 2000), I could deduce the difficulties faced by these teachers when they teach evolution since the category delineated the belief system of the teacher.

Scott (2000) presents the creation or evolution controversy as a continuum with creationism at one end and evolution at the other. The continuum refutes the dichotomy of the controversy with "creationists" being labelled as believers in God and "evolutionists" as atheists. Figure 2, on the next page illustrates the beliefs of the different groups. This continuum will assist with describing the religious beliefs of teachers so that when a teacher describes themselves as being a "creationist", the researcher can then ask, "what kind?" Scott (2000) describes each category as follows:

- Flat Earthers are those who believe that the Earth is flat because of the literal reading of the Bible demands it. When the Bible refers to the "four corners of the Earth" they believe that the meaning is the geographical cardinal points and that the Earth is coin-shaped rather than spherical.
- Geocentrists accept that the Earth is spherical but that the Earth is the centre of the solar system with the sun moving around the Earth. This group rejects most of modern physics, chemistry and biology.
- Young Earth Creationists interpret the creation in Genesis as literal: God created all living things in 6 consecutive 24 hour periods. They reject modern physics, chemistry and geology. The Earth according to the young Earth creationist is 6 to 10 thousand years old. They will reject biological descent with modification.

CREATION

Flat Earthers-are those who believe that the Earth is flat because of the literal reading of the Bible.

Geocentrists - accept that the Earth is spherical but that the Earth is the centre of the solar system with the sun moving around the Earth

Young Earth Creationists -interpret the creation in Genesis as literal: God created all living things in six consecutive 24 hour days

Old Earth Creationists -merge ideas of special creation with scientific ideas of evolution

***Gap Creationism* -**believe that there is a temporal gap between Genesis chapter 1:1 and chapter 1:2. The creation of the world and then the gap before Adam and Eve were created accommodates for the Earth being billions of years old

***Day-Age Creationism*-**believe that the length of each creation day was not 24 hours but rather millions of years.

Progressive Creationism- can be reconciled with science and accept the fossil record as an accurate representation of history.

***Intelligent Design Creationism*-**believe that the extraordinary complexity of all organisms could not have evolved by chance and had to have been guided by an "intelligent designer" who is God

Evolutionary Creationists- believe that God is the creator and that He uses evolution to bring about the universe according to His plan

Theistic Evolutionists -believe that God created the world through the laws of nature. They will accept that one species give rise to another; they accept descent with modification.

Material Evolutionists -have a non-religious belief system that only accept scientific explanations for the origin of life and its diversity

EVOLUTION

Figure 2: Creation / Evolution continuum

(Adapted from Scott, 2000)

- Old Earth Creationists merge ideas of special creation with scientific ideas of evolution. Within this group are subgroups that accommodate creation and evolution in different ways.
    - Gap Creationists believe that there is a temporal gap between Genesis chapter 1:1 and chapter 1:2. The creation of the world and then the gap before Adam and Eve were created, accommodates for the Earth being billions of years old.
    - Day-age Creationists believe that the length of each creation day was not 24 hours but rather millions of years.
    - Progressive Creationists believe that special creation can be reconciled with science and accept the fossil record as an accurate representation of history. However this group of people reject the conclusion that earlier forms are related to later ones and that descent with modification does occur. “Evolution within a kind” will occur where a created cat will differentiate into the different species of cat like lions, tigers, leopards or pumas.
    - Intelligent Design Creationists believe that the extraordinary complexity of all organisms could not have evolved by chance and had to have been guided by an “intelligent designer” who is God. They will support microevolution but believe that natural selection and mutation are not suitably adequate to explain the evolution of some organisms to others.
- Evolutionary Creationists believe that God is the creator and that He uses evolution to bring about the universe according to His plan. The belief is similar to the theist evolutionist but this group consists of more conservative Christians.
- Theist Evolutionists believe that God created the world through evolution. They differ in whether and how much God is allowed to interfere. Some believe that God intervened at critical intervals during the history of life, in particular the origins of humans while others believe that humans may be descended from the more primitive forms but that God intervened for the creation of the human soul.
- Material Evolutionists have a non-religious belief system that only accepts scientific explanations for the origin of life and its diversity. Some believe that that the supernatural does not exist and reject the ideas of creationists whilst others are neutral to religious ideas (Scott, 2000).

Since the research involves Muslim teachers, the continuum needs to include the belief system of Muslims. Hameed (2008) suggests that there is no official opinion of evolution by

Muslims. However, he clarifies certain perspectives of Islam. The Koran has a six-day account of creation. The length of each day in the Koran has not been specified and the implication from the Koran is that the Earth is billions of years old. This would ascribe the belief of most Muslims to be creationists and would be Old Earth creationists according to Scott (2000). By using Scott's (2000) continuum (fig. 2), most Muslims who are creationists would then ascribe their belief to be Day-age creationists where the length of each created day would not be 24 hours but rather millions of years.

According to Hameed (2008), certain Western Islamic scholars reject evolution theory whilst others do accept evolution but exclude human evolution. Those scholars who accept evolution theory but exclude human evolution will fit in with the continuum (fig. 2) as progressive creationists. There could also be Muslims who would fit into the other positions on the continuum.

2.6 Relationship between science and religion

This framework will assist in the answering of research question two. Barbour (2000) presents four possible categories that can be used to categorise the personal beliefs of teachers on the relationship between science and religion. These categories were used to determine how the religious beliefs of some teachers would influence their teaching. Teachers could experience conflict, independence, dialogue or integration when they teach evolution.

- Conflict

  The teacher who falls into this category believes that science and religion have conflicting stances. There are those who read the bible literally and who maintain that evolution is contrary to their faith. Atheist scientists are at the other opposing end and claim that evolution is incompatible with any religious beliefs. Teachers who experience conflict might tell learners that they have to learn the theory to pass an examination but that the learners would not necessarily have to believe any of the theory. These teachers may teach evolution superficially or they may spend too little time teaching evolution. Teachers experiencing conflict may also not teach evolution at all or may even try to "poke as many holes in it" as they can (Aguillard, 1999: 185).

- Independence

  Science and religion are seen by this group of teachers as independent of each other. This group of people will say that religion deals with a belief system and science deals with the "how" question. The group of teachers who find themselves in this position are those teachers who would teach the Science of

evolution and do not involve themselves in the conflicting beliefs of their students or the conflicts that their students would find themselves facing. These teachers would inform their learners that they should learn what they need to pass examinations.

- Dialogue

  Teachers with this persuasion believe that science and religion should be in a dialogue with each other. With this outlook theologians and scientists can enter into a dialogue with both of them respecting the other's integrity. The teachers in this category would acknowledge that there can be conflict with the teaching of evolution but would seek to find some common ground where religious beliefs and scientific facts could meet. In a religious setting, the teacher would quote the theological text to reinforce a belief and then present a scientific fact of evolution. In a non-religious setting the teacher could present a religious fact and then present the aspect of evolution being taught.

- Integration

  This would involve the integration of science and religion where some would, for example, seek the evidence of God in nature. Other teachers would reformulate the religious concepts to include science. Some teachers would also interpret scientific and theological ideas within a mutual conceptual framework. The teacher would then attempt to incorporate scientific ideas into the creation account. This could occur in a religious or non-religious setting where the teacher would be able to switch from religion to science and vice-versa.

2.7 Teachers and conflict

I investigated the strategies, if any, that were used by some teachers to cope with the conflict between science and faith when they teach evolution. Meadows,*et al.* (2000) propose a model of beliefs about religion and beliefs about evolution (see Fig. 3). The two lines represent the beliefs about religion and beliefs about evolution. The lines are far apart at the beginning of the diagram and represent a category of teachers who are unaware of the conflict between beliefs about religion and beliefs about evolution. This situation does not seem possible in the South African scenario since the teaching of evolution in Life Science is a controversial affair with the media and different religious organisations publishing different aspects of the controversy. Most teachers teaching evolution in South Africa are aware of this controversy and are aware of this conflict.

The lines start to move together to indicate the next category of teachers who are aware of the conflict but avoid it. These would be most teachers teaching evolution since avoiding the conflict would be ideal. Stears (2006) in her study of South African teachers identified a group of teachers who believe that evolution should be taught as scientific fact without any reference to a belief system. These teachers would teach students the theory and the evidence of evolution but would emphasise to the students that their belief was their own.

The next category of teachers includes those teachers who are disturbed by the conflict and who are attempting to resolve this conflict. These teachers would outline the controversy when they teach evolution and then would attempt to resolve the arising conflict with learners. This correlates with the group of teachers that Stears (2006) identifies who believe that evolution is not in conflict with belief systems.

The lines are closer and parallel to each other to indicate those teachers who are managing the conflict. According to Meadows,*et al.*, (2000) managing the conflict means that these teachers move comfortably back and forth between the two systems of beliefs. This model will be used to identify teachers who are managing the conflict between science and religion.

This model will assist in recognizing the respondents teach evolution and how they cope with the conflict of faith and science when they teach evolution.

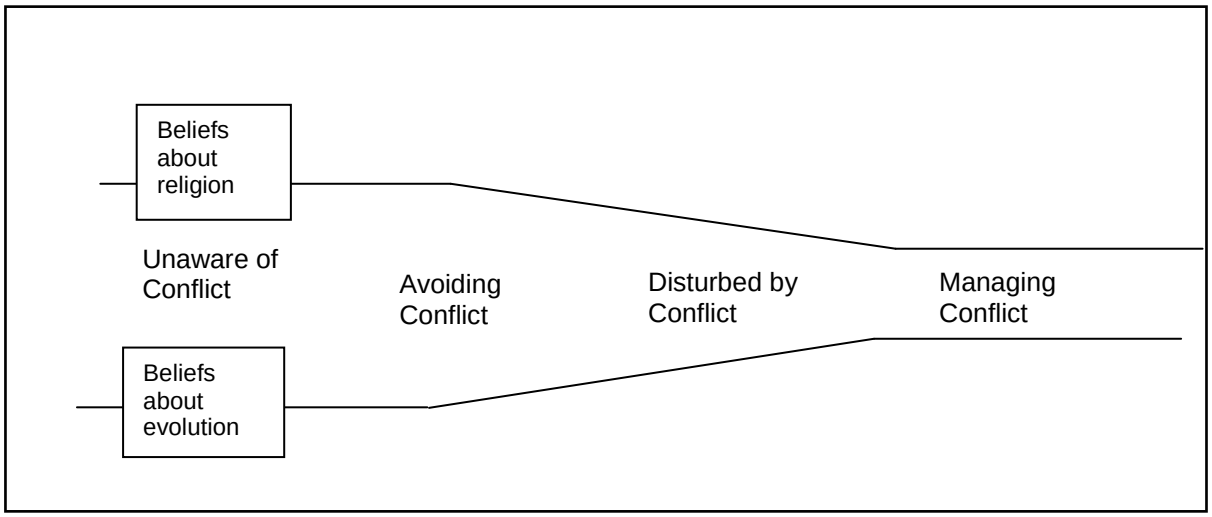


Figure 3: Categories of conflict

(extracted from Meadows,*et al.*, 2000)

2.8 Border crossing

The term border crossing was first used by Giroux (1992) when he described the difficulties faced by students whose race and culture differed to the majority of the student body. Giroux (1992) stated that only when these cultural divides were considered and acknowledged could these students begin to learn. Aikenhead (1996) used this concept to apply to school science when he suggested that for students to learn school science they need to cross a border from the culture of their home to school science. Border crossing occurs when the everyday science experiences or worldviews of students are different from those experienced or expected in school science. Border crossing will occur especially when one worldview is different from another and it is then that students are expected to cross borders between the different worldviews. Aikenhead and Jegede (1999) proposed different approaches that teachers can use to describe these difficulties. The border crossings that students experience could then be described as being *smooth, manageable, hazardous* or *impossible.*

The ease with which border crossing occurs is dependent on the overlap between the students existing culture and the culture of school science (Aikenhead, 1996). Figure 4 is my representation of Aikenhead's (1996) concept of border crossings.

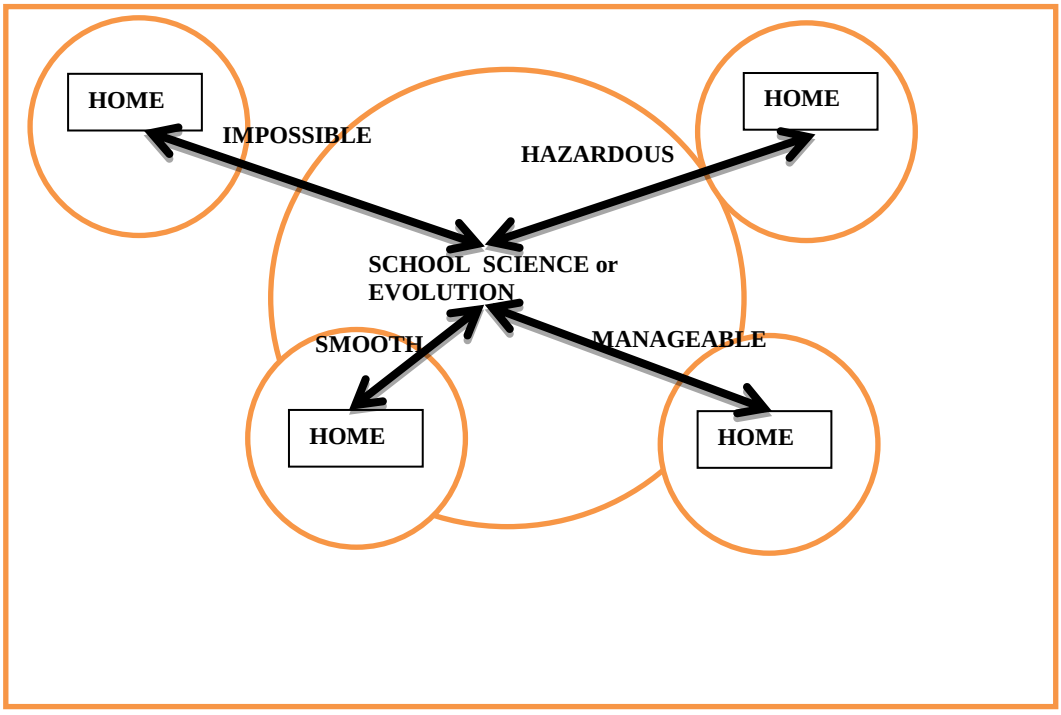


Figure 4: Border crossings that are described as impossible, hazardous, manageable or smooth

The concept of border crossing can be applied to teachers as well as to students. In this study, teachers with strong religious beliefs are expected to cross borders when they teach evolution. The border crossings the teachers would experience could then be described as *smooth, manageable, hazardous* or *impossible* depending on the degree of difficulty experienced by the teacher when making that crossing. The ease with which border crossing occurs for these teachers is dependent on the overlap between their religious beliefs and the concept of evolution.

Abrie (2010) observed that the majority of future teachers are unwilling to teach evolution as a compulsory part of the curriculum. Aguillard (1999) also notes a group of teachers who sabotaged their teaching of evolution where one teacher is quoted as saying: "I try to poke as many holes in it as I can". A further group identified by Abrie (2010) will avoid or only briefly mention evolution in their biology classes. The border crossings of teachers with strong religious beliefs who refuse to teach evolution or who sabotage their teaching of evolution can be described as being *impossible*.

Research by Ngxola and Sanders (2008) indicates that one of the concerns that teachers' have is that the topic of evolution is controversial. Teachers were concerned that evolution would contradict religious beliefs and confuse learners. Another concern involved the conflict between the teachers' own religious beliefs and evolution. Abrie (2010) observed from a study of future teachers at a historically Afrikaans, South African university that many of these future students have deeply set religious views that are in conflict with the theory of evolution. Amongst these students Abrie (2010) identified a group of teachers that would teach from a creationist viewpoint and deal with evolution only reluctantly because it is compulsory part of the curriculum, instead of teaching evolution as the cornerstone of modern biology. The teacher who is strongly religious and who has the misconception that acceptance of evolution is contradictory for a religious person has to now cross science borders when moving from creation to evolution. This border crossing that the teacher would then experience could be described as *hazardous* for this teacher.

Stears (2006) identified a group of teachers who would teach evolution as part of the curriculum but would emphasise to learners that they did not have to believe it. These teachers would experience border crossings that are *managed*. They would emphasize to learners the importance of learning evolution to pass examinations even though the content of evolution being taught is contradictory to the learners' religious beliefs.

Stears (2006) describes another group of teachers who believe that evolution is not in conflict with belief systems. *Smooth* border crossings would be experienced by these teachers with strong religious beliefs, when their religious beliefs and the content they teach in "evolution" overlap.

2.7 Conclusion

This chapter provided four analytical frameworks that are used to answer the research questions. Scott (2000) provided a creation / evolution continuum which is used to answer the first research question of what viewpoints teachers with strong religious beliefs have about creation and evolution. Barbour (2000) proposed four possible responses that teachers with strong religious beliefs can portray when they teach evolution. These responses can describe how teachers with strong religious beliefs teach evolution. Meadows, *et al*. (2000) propose a model of beliefs about religion and beliefs about evolution. This model can be used to explain how teachers are able to cope with the conflict of science and faith when they teach evolution. Finally teachers experience border crossings that are smooth, manageable, hazardous or impossible when they teach evolution.

In the next chapter, I describe the research paradigm and explain the method of sampling to determine the respondents. The type of interviews and questions presented to the respondents are also explained. The advantages and disadvantages of the chosen data collecting tool, namely interviewing is also discussed. Ethical issues and the rigour in the research are also discussed.

CHAPTER THREE

RESEARCH DESIGN

3.1 Introduction

The aim of this research was to gain insight into the teaching of evolution by teachers who have strong religious beliefs. Initially, I identified the difficulties faced by some teachers with strong religious beliefs when they teach "evolution". Thereafter, I ascertained how the strong religious beliefs of some teachers influenced their teaching. And then, I investigated the strategies, if any, that were used by some teachers to avoid the conflict between science and faith when they teach evolution.

The following research questions were answered during the study:

1. What viewpoints do teachers with strong religious beliefs have about creation and evolution?
2. How do teachers with strong religious beliefs teach evolution?
3. How do teachers manage the conflict of science and faith when teaching evolution?
4. What are the difficulties that are faced by some teachers with strong religious beliefs when they teach evolution?

3.2 Research paradigm

Henning, Van Rensburg and Smit (2004) define a paradigm as "a theory or hypothesis" whilst Guba and Lincoln (1994) explain that a paradigm may be viewed as a set of basic beliefs that first deals with principles. A paradigm represents a worldview that outlines the nature of the world, the individual's place in it, and the range of possible relationships to that world and its parts (Patton, 1990). A paradigm can also be seen as a framework from which a theory can be constructed that reflects on how the researcher sees the world. The research paradigm determines the researcher's perspective on the research and ultimately the position the researcher would take with regard to the subject of their research. This case study is set within the interpretive paradigm (Cohen, *et al.*, 2007)

Ontology specifies the nature of reality that is to be studied and what can be known about the nature of reality.Within an interpretative paradigm the world is considered to be multifaceted and dynamic and is assembled, understood and experienced by people in their relationships with others and wider social situations. "Situations are fluid and changing rather than fixed and static", (Cohen,*et al.*, 2007: 20). People act and think deliberately and also

actively construct their world. Because people experience reality in different ways, each person's reality is important and each person experiences reality in different ways. For the researcher the use of language will define a particular reality.

Epistemology specifies that the nature of the relationship between the researcher and the known. This is a subjective point of view where the knower and known are inseparable. The knowledge develops as a human construction where the researcher and participant construct understandings (Hatch, 2002). The products outline the forms of knowledge that can be produced. In this study the product takes the form of a case study. The methodology specifies how the researcher may go about practically studying whatever he or she believes can be known.

Henning, *et al.*, (2004) outlines the distinction between qualitative and quantitative research in terms of controlling the variables. When qualitative research is done,the variables cannot be controlled because respondents have opportunities to express themselves outside of the research instrument. Research of this nature requires an in depth study of the natural situation and the respondents in the research.

This research is a qualitative study that focused on natural settings. In this study collective case studies were undertaken where teachers with strong religious beliefs were asked about their own meanings about evolution and the manner in which they teach evolution. These meanings may have originated from their religious beliefs. When they experienced conflict between science and faith the teachers might have experienced difficulty teaching evolution. They may develop or adopt or construct certain strategies to minimise or avoid the conflict.

3.3 Research approach: Case study

Case studies provide the opportunity for the researcher to focus on one case in point and to investigate that one illustration (Opie, 2004). Cohen, *et al.* (2007) describe the case study that is frequently designed to illustrate a more general principle. The case study is of a bounded system where the example can be a child, a clique, a class, a school or a community. In this research eight teachers were selected for an in-depth interview. The case study is an interpretative description and analysis of two groups of teachers with strong religious beliefs. The teachers involved were either Muslim or Christian and they were Life Science teachers who taught evolution to grade 12 learners.

Hitchcock and Hughes (1995) outline the characteristics of a case study where it focuses on individual actors or groups of actors and seeks to understand their perception of events. In

this study I endeavoured to discover how the strong religious beliefs of the teachers influenced their teaching. The case study also enabled me to explore how the religious beliefs of teachers influence their teaching of evolution. Case studies involve real people in real situations (Cohen,*et al.*,2007) and in this research the teachers with strong religious beliefs were interviewed to explore how they teach evolution. The researcher is also integrally involved in the case (Hitchcock & Hughes, 1995). In this study I aligned myself with the community and the teachers involved. When I interviewed a Muslim teacher, I acknowledged my roots in the predominantly Muslim Indian area in which I was raised and when I interviewed a Christian teacher I acknowledged that I am a Christian.

Stake (1995) identifies three main types of case study: intrinsic case studies, instrumental case studies and collective case studies. With collective case studies groups of individuals are studied in order to gain insight into a more complete perspective. With this study the individual teachers were grouped as being either Muslim or Christian to develop an insight into how their religious beliefs influenced their teaching. The study is a collective case study where a group of teachers with strong religious beliefs is studied to gain insight into the difficulties they faced when teaching evolution. Teachers were interviewed to gain a more complete perspective into the manner in which they teach evolution and to establish how they managed the conflict between science and faith when they teach evolution.

3.4 Sampling

Purposive sampling of respondents to gather relevant data was done. Purposive sampling occurs when respondents are hand-picked by the researcher for some characteristic (Opie, 2004). The strength of purposive sampling lies in selecting information-rich cases for in-depth study. Information-rich cases are those from which one can gather data that is relevant for the study. The information-rich data can yield insights and in-depth understanding rather than empirical generalizations (Patton, 1990).

Patton (1990) proposed the snowball or chain type of purposive sampling. This type of sampling was used to identify the respondents to be interviewed. Snowball or chain type of sampling occurs when cases of interest are identified from people who know what cases are information rich, that is, good examples for study or good interview subjects. Of the eight teachers interviewed, four of the teachers (two Muslim teachers and two Christian teachers) are teaching in a religious school and the other four (two Muslim teachers and two Christian teachers) teachers in secular schools. Teachers with strong religious beliefs were identified who may have avoided the conflict or who might have been disturbed by the conflict or who may be managing the conflict between science and faith when teaching evolution. The

teachers who were identified were of the Muslim and Christian religion. None of the teachers that were identified belonged to the Hindu religion nor were there any teachers identified who belonged to another religion. The two Muslim teachers in secular schools were identified by another Muslim teacher as being teachers who were very knowledgeable about the teaching of evolution. The Christian teachers teaching in secular schools were identified by other teachers as being good subjects to interview. One of the teachers teaching at a Christian school was identified by a colleague since she had taught at that school previously and was impressed at the manner in which evolution was taught even though she experienced difficulties when teaching evolution.

3.5 Data collection

To collect data from teachers in schools in the Gauteng area, I obtained permission from the Gauteng Department of Education. Permission was granted on condition that interviews were done after school and not during the last term of the year. I phoned principals of the schools where the identified teachers taught in order to get consent to interview the teacher concerned. All the principals I phoned indicated their willingness for the teachers to participate. I then contacted the teachers and made the necessary arrangements for the interview. This involved initially phoning the teachers and asking them if they were prepared to be interviewed. The principals were also phoned to obtain their assent for the teacher at their school to be interviewed. I also ensured that the forms where both the principals and the teachers gave their informed consent were completed prior to the interview being completed.

3.6 Methods

In-depth interviews were used. I did ask the teachers to provide lesson plans or some other lesson preparation to expand on the data received during the interview.

3.6.1 Document analysis

I wanted to do document analysis with the Grade 12 lesson preparation of the teachers who were interviewed. I requested only the lesson plans that were relevant to the evolution of humans. The NCS lists the requirements of a learning programme for teachers to plan and design lessons. The learning programme comprises of a work schedule and lesson plans. The Work Schedule for grade 12 for Life Sciences is divided into units of deliverable learning experiences, that is, lesson plans (Department of Education, 2007b). The lesson plan according to the Department of Education (2007a) will not only add to the level of detail in the work schedule but will indicate other relevant issues to be considered when teaching and assessing Life Sciences. However the actual lesson plan provides scant information. The

lesson plans of teachers should indicate the manner in which lessons are taught and any other relevant issues that the teacher will consider to be important in the teaching of the lessons. A teacher with strong religious beliefs who is teaching evolution might include issues of faith and science in the lesson plans. By analysing the lesson plans the researcher should have been able to expand on the information provided by the respondent during the interview.

However, I found that the lesson plans did not necessarily include the teacher's reflections. They were scant and did not reflect the manner in which the topic was taught. Some teachers stated that they did not have lesson plans but photocopied the textbook or study guide. When this occurred then I asked for whatever preparation was done by the teacher. When the teacher was reluctant to provide the lesson preparation, I asked about the resources that were used by the teacher to present the lesson. This could have provided any additional data that the respondent may have alluded to during the interview. The lesson plans provided by the teachers did not produce any usable data.

3.6.2 Interviews

My research into how teachers with strong religious beliefs teach evolution is an intrusion into the personal belief system of the respondents since teachers had to outline and explain their belief systems and the impact that these belief systems can have on their teaching. This needs to be handled with sensitivity.

Piloting of the instrument was carried out with two teachers. I had originally planned to pilot the instrument with three teachers but due to the unavailability of one of the teachers only two teachers participated in the pilot study. Piloting was done so that I as the researcher grew accustomed to handling difficult questions with the sensitivity required. Piloting also indicated whether the questions in the interview schedule were pertinent and clear and if the respondents were capable of answering the questions. There were some questions in the interview schedule that had to be rephrased to avoid ambiguity and other questions inserted to probe the answers provided and to gain insight into the beliefs of the respondents.

There are two issues that need to be ascertained from the respondents, the first is how teachers with strong religious beliefs teach evolution and second is how these teachers manage the conflict of science and faith when they do teach evolution. Interviews, rather than questionnaires, provide the platform where respondents can be encouraged by using probing questions. I asked for examples and experiences with learners in the classroom so that teachers could describe their faith and belief systems and also to determine the manner

in which the teachers handled the conflict of faith and science. An interview is described by Kvale (1996: 51) as an attempt to "obtain descriptions of the life world of the interviewee" in order to interpret the described phenomena. The description of the teacher's belief system and the description of the impact that their belief system has on their teaching of "evolution" are investigated so that the researcher can describe the different life worlds presented by the different respondents.

I asked both structured and semi-structured questions. Structured questions are controlled by me as the interviewer and are less flexible than unstructured questions. I could get clear unambiguous answers from the respondents (Opie, 2004). The structured questions I asked were how long had they been teaching Life Sciences and if they enjoyed teaching Life Sciences. I also asked what religion a teacher followed. Semi-structured questions are more flexible but there is less control by me as the interviewer. However semi-structured questions provide the most valuable type of data (Opie, 2004). I asked teachers what they taught learners about the origin of humans and then I asked them if the content of the lesson was in conflict with their faith. When I asked these semi-structured questions of the teachers I was granted wider latitude where I could probe and expand the respondent's perspectives as to how their religious beliefs influenced their teaching of evolution.

The interview schedule can be found in Appendix 1. The rationale for the questions and the possible probes is provided in Table 1 on the next page.

Advantages of using interviews

The major advantage of interviews over questionnaires for these research questions that involve religious belief is that the interview has the potential to provide more accurate answers on certain sensitive issues. These answers that the respondents provide with the nuances and inflections are related directly to the researcher and allow the researcher to factor in the unspoken gestures during the interview. In one of the interviews a respondent pointed to a category on a creation / evolution continuum that she associated herself with whilst in another interview a respondent nodded in agreement. Interviews also allow for a greater depth of information than a questionnaire or survey can provide (Guba& Lincoln, 1988). An interview provides a better opportunity to develop a rapport between the interviewer and interviewee and makes it possible to approach a sensitive issue from a variety of perspectives. Since the interviewer and respondent are face to face there is a smaller chance that there would be any misunderstandings between the interviewer and interviewee than in a questionnaire.

There is also the flexibility that if the respondent does not understand the question the interviewer can rephrase the question so that the question is clear to each respondent. If the interviewer suspects that the respondent is not wholly truthful in the response, the interviewer can ask further questions to elicit the truth. A pragmatic advantage of interviews is that they can be carried out more quickly than observation and costs less than surveys (Opie, 2004). Standardised open ended interviews where respondents are asked the same questions increase the "comparability of the responses" and expedite the organisation and analysis of the data (Cohen, *et al.*, 2007: 353).

Table 1: Rationale for interview questions

Key:	
(**RQ1**) Research question 1:	What types of perspectives do teachers with strong religious beliefs have about creation and evolution?
(**RQ2)** Research question 2:	How do teachers with strong religious beliefs teach evolution?
(**RQ3**) Research question 3:	How do teachers manage the conflict of science and faith when teaching evolution?

Main Questions	**Possible Probe**	**Reason**
Introductory questions		Respondents to be comfortable with the interviewer. Easy non-threatening question.
How long have you been teaching Life Sciences/ Biology?		
Do you enjoy teaching Life Sciences/Biology?		
Describe the best teaching situation that you have ever experienced.		
What are the most important values that you want to develop in your students?		
Present the addendum to the teacher of the changes in the curriculum		
The curriculum has changed for grade 10 in2009, and will change for grade 11 in 2010. The present grade 12 syllabus was taught for the first time in 2008 and will change in 2011. What do you think about the change in the curriculum relating to biodiversity, change and continuity?	 Ask for clarification. Can you explain (what the respondent has answered)?	Respondents to be comfortable with the interviewer. Easy non-threatening question. (RQ1)
There have been certain sections that have been included for the first time in the grade 12 curriculum last year. Do you think "evolution" be taught at high school?	When you taught grade 12 with the previous curriculum, you did not teach evolution. Do you think a grade 12 learner needs to learn about "evolution"?	To ascertain if there is a conflict of faith and science. (RQ3)
What is your religion?	What denomination do you belong to? (Christian teachers only)	To ascertain the faith/ belief system. (RQ1)

Does your faith/religious belief influence your teaching of evolution? In what way does your faith/religious belief influence your teaching of evolution?	How do you decide what to teach and what not to teach when you teach evolution?	To ascertain if there is a conflict of faith and science. (RQ1) (RQ2)
What is your belief about how man originated?		To categorize the belief system of the teacher by means of Scott's (2000) creation – evolution continuum. (RQ1)
There are certain belief systems that state that God created life as it is now. What do you believe? To what extent does your religious belief coincide with evolution?	Ask for clarification. Could you explain what you said?	To categorize the belief system of the teacher by means of Scott's (2000) creation – evolution continuum. (RQ1)
What do you teach learners about the origins of man? Is this in conflict with your faith?	Silent probe Overt encouragement. E.g. okay, oh, uh-huh If no ask for clarification. If yes ask how do you deal with this conflict?	Relationship between science and religion (Anderson, 2007) (RQ1); (RQ2) To establish which problems, if any may arise from teachers within this group, for example: - Some teachers who will not teach evolution at all - some teachers who will sabotage the science in the teaching of evolution - some teachers who will teach evolution as part of the curriculum but would emphasise to learners that they did not have to believe it To categorize the type of conflict as per the model of Meadows,*et al.,*(2000), if there is a conflict. (RQ3)
How do you teach evolution?	What resources do you use when you teach evolution? Ask for clarification, if necessary.	(RQ2)
If a learner in your class does not believe that evolution has occurred what strategy would you suggest to the learner to prepare them for the final examination?	What strategy would you suggest to this learner when you teach evolution?	To determine the strategies used by some teachers to teach evolution that avoids the conflict between science and faith. (RQ2)
What do you teach about the origin of species? Is this in conflict with your faith?	Silent probe Overt encouragement. E.g. okay, oh, uh-huh If no ask for clarification. If yes ask how do you deal with this conflict?	Relationship between science and religion (Anderson, 2007) (RQ3) To establish which problems may arise from teachers within this group: - Some teachers who will not teach evolution at all - some teachers who will sabotage the science in the teaching of evolution

		- some teachers who will teach evolution as part of the curriculum but would emphasise to learners that they did not have to believe it (RQ1)

When I asked the question: “what do you teach about the origin of species?” the answers from the respondents were that they were either teaching creationism or that they were teaching the science of evolution.

During the course of the interviews, I ensured that the teachers who were being interviewed were at ease where I attempted to develop a rapport with them. To achieve this, I interviewed teachers at the schools where they taught and asked introductory questions that they would feel comfortable answering. I was also able to rephrase questions when the respondents were unclear as to the meaning of the questions. I also found it necessary to ask further questions to elicit information that was not wholly clear from the respondent.

Disadvantages of using interviews

A disadvantage of interviews over questionnaires is that it is difficult to generalise about entire populations since studies are based on small samples. However, with this research there is no intention to generalize results but togain an insight into the teaching of evolution by teachers with strong religious beliefs. Interviews are also time-consuming but the insights gained by the research will justify the time commitment (Osborne & Gilbert, 1980). There can also be a lack of standardization in the interviewing procedure since the way in which a question is asked can differ from one interview to the next. However this can be minimised with an interview schedule (Foddy, 1993). The quality of the data collected is dependent on the interviewer. During one of the interviews while the respondent was answering a question the school bell started to incessantly ring. I asked the respondent to wait until the bell stopped ringing before she answered the question.

The respondents whom I interviewed were enthusiastic about the interview. At times they provided me with more information than I required in response to the question. This did however; provide me with additional insight as to how the religious beliefs of these teachers influenced their teaching. I could tentatively explore the strength of the religious belief of each teacher. The interview schedule that I used provided some measure of comparison since the same questions were asked of each of the respondents. Different answers were given by the respondents because I, as the researcher asked further questions to probe their responses. However, I did find that the interviews took considerably more time than I had originally allocated. There were two interviews that took about an hour to complete whilst the other interviews ranged from 25 to 45 minutes.

3.6.3 Recording data

The teachers interviewed had to consent to the interviews being recorded. The rationale for recording the interview being that it would be less time consuming and that their responses would be accurately recorded. The interviews were recorded on a digital recorder to ensure that the information was recorded accurately and without disruption to the flow of the interview. Tape-recording would also reduce the bias of the interviewer to consciously select data (Henning*et al.*, 2004). I used a digital recorder because it was unobtrusive and I could get as much data as possible (Cohen,*et al.*, 2007). Transcribing the interview afforded me as the researcher a check mechanism to verify the accuracy of data and also increased validity in the study. I completed the transcription of the data as soon as possible after the interview. This occurred on the same day. This allowed me to remember certain terms such as "mufthia school" meaning a Muslim school that abides by the teachings of the Koran. I could also record the unspoken gestures and authenticate the accuracy of the data when the recording quality was poor. When a word was not clearly enunciated or when the recording was not clear, I recalled the interview and then remembered the word.

3.7 Data analysis

The data was analysed by interpreting the data on the transcribed interview. Coding, as defined by Kerlinger (1970), is the interpretation of question responses and interviewee information into specific categories for the purpose of analysis. Coding can be further described as the category label the data is ascribed to. I had to systematically go through the transcribed data line by line and write a descriptive code on the side of each piece of data. These codes were then abbreviated so that I was able to immediately understand the issue that is being described. The coding resembled the original data so that I, as the researcher could identify the original data by seeing the code. The analysis of the data will be discussed in the next chapter.

3.8 Rigour in the research

Lincoln &Guba (1985) describe trustworthiness as to how an inquirer can persuade the audience that the findings of an inquiry are worth paying attention to. In particular, the arguments put forward by the researcher, the criteria involved in the research, and the questions asked influence the trustworthiness of the research undertaken. Trustworthiness will involve credibility, transferability, dependability and confirmability. Stuurman (1999, in Opie, 2004) provides strategies that enhance credibility. Some of the following strategies were be used, i.e. data-gathering procedures are fully explained; the data is presented transparently; negative instances are reported; biases are acknowledged; the relationships

between claims and supporting evidence will be clearly expressed and procedures are used to check the quality of the data.

In order to maintain transparency, I explained both to the principals and the teachers interviewed that both the school and the teachers would remain anonymous. Recording of the interview on a digital recorder ensured that accurate transcripts were provided of the responses from the teachers being interviewed. The respondents were provided with the details of the data-gathering procedures. I offered the respondents the opportunity to review and, where necessary, edit the written transcript of the interview. All the respondents declined the need to review or edit the written transcript of the interview. I also offered to provide the respondents with a copy of the research. All, except one, declined to accept a copy of the research. I validated the data from the interviews with the analysis of the lesson plans when these were available. However, lesson plans were sometimes too brief and oft times lacked the reflection of the teacher's religious beliefs.

The interview schedule was content validated by two experts in the field of research and Life Sciences. Content validity ensures that the instrument used measures all aspects of what you intend it to measure. This means that an expert in the field evaluates the interview schedule on the teaching of evolution. The interview schedule has to have a degree of structure where questions are ordered. According to Foddy (1993), the questions asked should be relevant and free of jargon. The questions asked should also be in context so that the respondent understands what kind of answer is required (Foddy, 1993). Novak and Govin (1984) suggest that the room that is used should be where there is no interruption and a minimum of background noise

The interviews took place at the schools where the teachers taught thus I could not predetermine the venue. However, before I started the interview I asked the respondents for a venue that was comfortable to them and where there was as little distraction as possible. I did make the necessary arrangements for the time of the interview and indicated that the interviews would be about 20 minutes but this did not necessarily hold true since interviews did sometimes take longer.

3.9 Ethical Issues

I applied for clearance to conduct the interview from the Human Research Ethics Committee (non-medical) of the University of Witwatersrand to adhere to the research ethics requirement. The committee granted me the clearance necessary to conduct the study. I also had to apply to the Gauteng Department of Education to get approval to conduct

research in the secular schools. I was granted permission to proceed with the study subject to a list of conditions. The condition that was the most stringent was that the research must be concluded before the end of the third term and that the research should take place after school hours.

Bell (1987) suggests that the interview process must not be intrusive, misleading or irritating to the participant and most importantly must not cause harm. In order to achieve these ideals there are ethical principles and standards that delineated the research. The initial aspect of ethics is to obtain informed consent from participants. This involves total honesty on my part when approaching possible participants; participants were fully informed as to the purpose of the research before getting their consent.

The following information sheets were given to the teacher and the principal and informed consent forms were signed before any data was collected:

- Information sheet for Grade 12 Life Science educators in schools where interviews will take place;
- Informed Consent Form for Grade 12 Life Science Educators for interviews;
- Consent for the interview to be audio recorded;
- The information letter sent to the educator of the school assured them that the teacher, the principal and the school will be guaranteed anonymity and that the interview would not impact on teaching or learning time.
  (APPENDIX 3 and 4)

The following information sheets and informed consent forms were given to the principal and were signed before any of the data was collected:

- Information sheet for principals in schools where interviews will take place with Grade 12 Life Science Educators;
- Informed Consent Form for Principals for Interviews and Consent for the interview to be audio recorded.
- The information letter sent to the principal of the school assured them that the teacher, the principal and the school will be guaranteed anonymity and that the interview would not impact on teaching or learning time.
  (APPENDIX 5 and 6)

One of the teachers identified was very wary of being interviewed when I telephoned requesting an interview. I then took the initiative of going to the school and having an

informal discussion with the teacher. The teacher was afraid that what was said during the interview may reach the community and the teacher was afraid of being ostracized by the community she taught in. Once I assured the teacher of anonymity the teacher then consented to being interviewed and to the interview being tape-recorded.

3.10 Conclusion

This chapter outlined the research process before, during and after data collection. The research paradigms, research questions, data collection procedures, data collection techniques as well as ethical issues and rigour were discussed in this chapter. The findings of the data analysis will be outlined in the next chapter.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter delineates the manner in which the data was analysed. Eight teachers were interviewed and the interviews transcribed. The transcriptions of the interviews provided the raw data. The raw data was analysed in conjunction with the analytical frameworks. These results are presented in the form of tables and are related to the analyticalframeworks used in the study. The aim of this research is to gain insight into the teaching of evolution by teachers who have strong religious beliefs. Initially, my intention was to identify the difficulties faced by some teachers with strong religious beliefs when they teach “evolution”. Thereafter, I ascertained how the strong religious beliefs of some teachers influence their teaching. And then, I investigated the strategies that are used by some teachers to avoid the conflict between science and faith when teaching evolution.

4.2 Data Analysis

Hatch (2002) describes data analysis as a search for meaning and a process whereby what has been learnt from the data can be communicated to others. Hatch (2002) proposes five models for analysing qualitative data. The most suitable model for interview data that have been collected with a narrow focus in mind is the typological analysis model. There are nine steps in typological analysis.

Identify typologies to be analysed

Typologies or coding as defined by Kerlinger (1970) is the translation of question responses and interviewee information into specific categories for the purpose of analysis. Questions can be pre-coded during the pilot studies so that each response from the interviewee can be directly translated into a score in an objective manner. The coding that was done linked the questions asked during the interview to the research questions and the following analyticalframeworks:

- Scott’s creation / evolution continuum (Scott, 2000)
- Four categories that could be used to categorise the personal beliefs of teachers about the relationship between science and religion (Barbour, 2000). These are conflict, independence, dialogue and integration
- A model of categories of conflict between beliefs about religion and beliefs about evolution (Meadows*et al.*, 2000). The teachers could be unaware of the conflict between

science about religion; avoid the conflict; are disturbed by the conflict and are managing the conflict between science and religion.

- Border crossing. Teachers with strong religious beliefs are expected to cross borders when they teach evolution. Teachers with strong religious beliefs could have worldviews that are different from those experienced or expected in school science when they teach evolution. The border crossings experienced by teachers could be described smooth, manageable, hazardous or impossible (Aikenhead &Jegede, 1999) depending on the degree of difficulty experienced by the teacher when making that crossing.

Read the data, marking entries related to your typologies

Once each interview was completely transcribed the data was post-coded from transcripts of the interview. Coding can be further described as the category label the data is ascribed to (Kerlinger, 1970). The researcher will systematically go through the transcribed data line by line and write a descriptive code on the side of each piece of data. These codes are linked to the analytical framework. The questions themselves were pre-coded since they were linked to the research questions and the analyticalframework. The pre-coding is shown in the interview schedule as part of the reason for the questions.Whilst reading from the transcripts of the interviews I found and marked the places in the transcript where evidence related to that particular typology is found. The relevant portions that fitted were highlighted in different colours.

Read entries by typology, recording the main ideas in entries on a summary sheet

A summary sheet was drawn up and as the data was reread a summary was made with the respondents actual answers relating to the relevant typologies. The steps followed in my analysis of data are proposed by Hatch (2002).

Look for patterns, relationships, themes within typologies (codes)

During the formulation of the research questions and the compilation of the interview schedule certain categories of information were emphasized. These related to the analyticalframework. As the data was being read, certain questions were answered in a similar manner by the respondents. These responses were coded accordingly. An example of this occurrence is the responses from the interviewees when asked about their opinion about the introduction of evolution to the curriculum. Their responses were either acceptance and approval of the inclusion of evolution or rejection and disapproval of the inclusion of evolution into the curriculum.

Read data, coding entries according to patterns identified and keeping a record of what entries go with which elements of your patterns

Each excerpt was coded both on the summary sheet and on a table.

Decide if your patterns are supported by the data, and search the data for non-examples of your patterns

There will be some data which has not been categorised into any code. The initial categories were then rechecked and all the data was reread to establish whether there was anything in the data that contradicted the finding.

Look for relationships among the patterns identified

In order for relationships among the patterns to be identified, the researcher has to move away from the individual analyses and look at the bigger picture. Detailed tables were drawn up to assist with this.

Write your patterns as one sentence generalizations

A generalisation will express a relationship between two or more concepts and will provide the mechanism to communicate to others what has been learnt from the data collected. The analytical frameworks were made use of namely: Scott's (2009) creation/evolution continuum; Barbour's (2000) four categories relating to the relationship between science and religion; Meadows, *et al*. (2000) categories of conflict and Aikenhead's (1996) border crossing. The words relating to the categories in the analytical framework were used.

Select data excerpts that support your generalisations

Hatch (2002) refers to "powerful examples" which can be quoted in order for the generalization to be meaningful to readers. These data excerpts allow the reader to familiarize themselves with the contexts and to hear the voice of the participants. Quotations from the interviews are used to substantiate the categorising of the analytical frameworks. These quotations also make the categorisation meaningful to the readers.

4.3 Results and discussion

The aim of this research was to gain insight into the teaching of evolution by teachers who have strong religious beliefs. Initially, I identified the difficulties faced by some teachers with strong religious beliefs when they teach "evolution". Thereafter, I ascertained how the strong religious beliefs of some teachers influenced their teaching. And then, I investigated the strategies, if any, that were used by some teachers to avoid the conflict between science and faith when they teach evolution.

The following research questions were answered during the study:

1. What viewpoints do teachers with strong religious beliefs have about creation and evolution?
2. How do teachers with strong religious beliefs teach evolution?
3. How do teachers manage the conflict of science and faith when teaching evolution?
4. What are the difficulties that are faced by teachers with strong religious beliefs when they teach evolution?

The results are presented in relation to the research questions and models used in the analytical framework. The first research question is answered by Scott's (2009) creation/evolution continuum and the additional information relating to Muslim respondents. The second research question is related to Barbour's (2000) four possible categories that are used to categorise the personal beliefs of teachers on the relationship between science and religion. Meadows, *et al*. (2000) propose a model of beliefs about religion and beliefs about evolution that is linked to the third research question. Border crossing (Aikenhead, 1996) is used as the fourth framework and is also linked to the third question. The difficulties experienced by each of the teachers were noted. Teachers experienced difficulties differently and these were also duly noted. The strategies employed by some teachers to avoid conflict are also noted. A summary of the findings can be found in Table 2 on the next page.

Table 2: Summary of findings

Pseudonym	Type of school	Christian (denomination) / Muslim	Category		conflict, independence, dialogue and integration	Disturbed by the conflict	Border crossing smooth, manageable, hazardous or impossible
Farhad	Government	Muslim	Old Earth creationist	Day Age creationist	Conflict	Managing the conflict	hazardous
Farhzana	Government	Muslim	Old Earth creationist	Day Age creationist	Conflict	Managing the conflict	hazardous
Farhana	Muslim	Muslim	Old Earth creationist	Day Age creationist	Conflict	Managing the conflict	hazardous
Fazhila	Muslim	Muslim	Evolutionary Creationist		Independence	Disturbed by the conflict	manageable
Charlene	Government	Christian (*NGK)	Evolutionary Creationist		Integration	Managing the conflict	smooth
Christine	Government	Christian (*NGK)	Young Earth creationist		Conflict	Avoid the conflict	impossible
Carmen	Christian	Christian (Methodist)	Theistic evolutionist		Dialogue	Managing the conflict	smooth
Catherine	Christian	Christian Pentecostal	Old Earth creationist	Progressive creationist	Conflict	Managing the conflict	hazardous

*NGK – NederduitseGereformeerdeKerk

4.3.1 Scott's (2009) creation/ evolution continuum

The table below indicates the categories of belief according to Scott's (2000) creation / evolution continuum for both the Muslim and the Christian teachers.

Table 3: Categories of teacher's belief according to Scott's (2009) creation/ evolution continuum

Pseudonym	Type of school	Christian (denomination) / Muslim	Category	
Christine	Government	Christian Reformed	Young Earth creationist	
Farhad	Government	Muslim	Old Earth creationist	Day Age creationist
Farhzana	Government	Muslim	Old Earth creationist	Day Age creationist
Farhana	Muslim	Muslim	Old Earth creationist	Day Age creationist
Catherine	Christian	Christian Pentecostal	Old Earth creationist	Progressive creationist
Fazhila	Muslim	Muslim	Evolutionary Creationist	
Charlene	Government	Christian Reformed	Evolutionary Creationist	
Carmen	Christian	Christian Methodist	Theistic evolutionist	

Three of the Muslim teachers were categorised as Old Earth Creationists. Farhad stated that the Earth is "definitely more than 6 000 years old". As a Day Age creationist these teachers would describe creation to have occurred not as six, 24 hour days but rather that each of the days would be millions of years. These findings correlate with the research done by Dagher and BouJaoude (1997) and Hameed (2008) with regard to the Koranic revelation of creation. Christine, the Christian teacher who is a Young Earth creationist stated that: "the Lord created Adam and Eve and He created life in 7 days".

On the other hand, Catherine, a Christian teacher is categorised as an Old Earth creationist but she differs from the Muslim teachers who are Day Age creationists because she is a Progressive creationist. A Progressive creationist will believe that special creation can be reconciled with science and accept the fossil record as an accurate representation of history. Catherine also states that: "I don't believe in a 7 day creation as it is literally set out in the Bible I believe that that is a figurative interpretation of how God ... I do believe He used evolution in the process of creating the earth and life but as I said I don't see man as an animal that merely evolved".

Evolutionary Creationists believe that God is the creator and that He uses evolution to bring about the universe according to His plan. Charlene declared that: “Yes I believe that God made us as we are now I just believe that it didn’t take Him 24 hours to do so. I believe he made us go through (evolution) – just like we can prove ... I know that there’s enough evidence to prove that we ... why did God put in the scientific evidence”. Hameed (2008) suggested that certain Muslim scholars would reject human evolution but would accept evolution theory. The Evolutionary creationist (Fazhila) would accept evolution. Fazhila explained that “because even in our books it is written that people of that time, they were quite tall more than 10 feet as compared with being a human being. That time people were quite tall but now the average height is less than 6 feet. Man has changed.” She has taught in India previously and has taught evolution for 7 years. This is relevant and ties in with findings by Rutledge and Mitchell (2002) where they note that teachers’ acceptance of evolution correlates with the increase in amount of preparation of the subject matter.

Theist Evolutionists believe that God created the world through evolution. They differ in whether and how much God is allowed to interfere. The Theistic Evolutionist, Carmen declared that: “I don’t believe in a 7 day creation as it is literally set out in the Bible I believe that that is a figurative interpretation”.

To summarise three of the Muslim teachers can be described as Old Earth creationists. These teachers can be further categorized as Day Age Creationists with one Muslim teacher categorized as an Evolutionary Creationist. The Christian teachers were categorised as a Young Earth creationist, an Old Earth creationist (Progressive Day creationist), an Evolutionary creationist and a Theistic evolutionist. This portrays the diverse nature of individual beliefs about evolution and creation as displayed in the continuum (Scott, 2000).

4.3.2 Relationship between Science and Religion

The table below summarises the categories of the personal beliefs of teachers about the relationship between science and religion according to Barbour (2000) for both Muslim and Christian teachers.

Table 4: Categories of the personal beliefs of teachers about the relationship between science and religion according to Barbour's (2000) categories

Pseudonym	Type of school	Christian (denomination) / Muslim	conflict, independence, dialogue and integration
Farhad	Government	Muslim	Conflict (enemies)
Farhzana	Government	Muslim	Conflict (enemies)
Farhana	Muslim	Muslim	Conflict (enemies)
Christine	Government	Christian Reformed	Conflict (enemies)
Catherine	Christian	Christian Pentecostal	Conflict (enemies)
Fazhila	Muslim	Muslim	Independence (strangers)
Carmen	Christian	Christian Methodist	Dialogue (partners)
Charlene	Government	Christian Reformed	Integration (closer partners)

Three of the Muslim teachers experienced conflict between science and religion. Two of the Christian teachers, Catherine and Christine also experienced conflict between science and religion. Catherine teaches her learners that although there is a similarity between the DNA of humans and chimpanzees, chimpanzees are definitely animals. Man, according to Catherine is specially created. Christine felt that she was being forced to teach evolution and that this is against her belief. The discord that she experiences stems from the belief that the quotations from the Koran or Bible are in direct conflict with the theory of evolution. The findings here tie in with studies done by Trani (2004), Rutledge and Mitchell (2000) and Moore and Cotner (2009) who noted a strong correlation between teachers with strong religious beliefs and their inability to accept evolutionary theory.

The fourth Muslim teacher, Fazhila taught the science of evolution independent of creation and did not involve herself in the conflicting beliefs of her students. She told them that: "belief- that it's up to you, whether you believe it or not, but I'll tell them that these are the theories and these are the proofs". Teaching in this fashion where the science of evolution is taught independent of religion is also endorsed by the National Science Teachers Association (1996) based in America. Having noted this however, teaching in a religious school where a part of the day is devoted to religious education and with the official stance of the school being antievolutionist it would be difficult for a learner with conflicting beliefs to embrace evolutionary theory.

One of the Christian teachers, Carmen also experiences a dialogue between science and religion. The teachers in this category would acknowledge that there could be conflict with

the teaching of evolution but would seek to find some common ground where religious beliefs and scientific facts could meet. This correlates with suggestions made by Clough (1994) where the views of students should be treated with respect. Carmen reinforced that notion when she stated that: “abortion from a religious point of view would be wrong and from my religious point of view it is not the right way to go but from a biological point of view and from a scientific point of view, the children need to understand that, that is there and it isn’t just something that we can just ignore. It is there and they need to understand what abortions are from a scientific biological point of view not from a religious point of view. They must now make that decision for themselves and I do the same with regards to evolution.” This is a profound statement from a teacher who teaches at a Christian school where learners are taught religious education.

The other teacher, Charlene experienced integration between science and religion where she discussed the evidence of God when she taught evolution. This inclusion of creation stories to teach evolution is also one of the suggestions made by Matthews (2001) to enrich the teaching of evolution.

In summary three of the Muslim teachers and two Christian teachers experience conflict between science and faith. One Muslim teacher taught the science independent of religion. Another of the Christian teachers believed that science and religion should be in dialogue with each other. The other of the Christian teachers attempted to integrate science and faith.

4.3.3 Teachers and conflict

The table below summarises the categories of conflict experienced by Muslim and Christian teachers (Meadows*et al.*, 2000).

Table 5: Categories of conflict experienced by teachers from Meadows,*et al*.(2000)

Pseudonym	Type of school	Christian (denomination) / Muslim	Categories of conflict
Christine	Government	Christian Reformed	Avoid the conflict
Fazhila	Muslim	Muslim	Disturbed by the conflict
Farhad	Government	Muslim	Managing the conflict
Farhzana	Government	Muslim	Managing the conflict
Farhana	Muslim	Muslim	Managing the conflict
Charlene	Government	Christian Reformed	Managing the conflict
Carmen	Christian	Christian Methodist	Managing the conflict
Catherine	Christian	Christian Pentecostal	Managing the conflict

None of the teachers interviewed is unaware of the conflict. One of the Christian teachers, Christine, attempts to avoid the conflict. Unlike the first category of teachers who are unaware of the conflict, the teacher in this category is very much aware of the conflict but will inform learners that creation and evolution are unrelated and will tell learners that the theory of evolution is unproven (Meadows*et al.*, 2000). Christine teaches learners about the "Piltdown man". The "Piltdown man" was a hoax in which the bones of an orang-utan and the bones of a modern human were presented together as the fossilised remains of an early human. She further explains to the learners that the knowledge (of the hoax) is a weapon in the defence of creationism. This teacher will also attempt to separate her own beliefs about creation from evolution (Meadows*et al.*, 2000). She reinforces this notion when she says that evolution is"only one person's opinion". She very obviously harbours misconceptions about evolution. These findings ties in with research done by Rutledge and Warden (2000) and further research by Rutledge and Mitchell (2002) where their findings indicate that teachers have misconceptions about aspects relating to evolution.

Teachers that are disturbed by the conflict "experience a troublesome state of cognitive and emotional dissonance" when they are faced with the discrepancies between their own religious and evolutionary beliefs (Meadows, *et al.*, 2000). One of the Muslim teachers, Fazhila is disturbed by the conflict. When she was asked to what extent does your religious belief coincide with evolution? She answered by saying: "That's a problem, you know when you fix your belief somewhere then you want to think everything that – whether your religion is right or whether what you're learning is right so you just keep both the things in mind".

Miller, *et al.* (2006) note that in Islamic countries Biology is taught in a highly religious environment and a consequence of this is the lower acceptance of evolution. This presents a personal dilemma to her since she teaches in a Muslim school where learners adopt an antievolution stance.

The fourth category are teachers who manage the conflict and most of the teachers, both Christian and Muslim fall into this category. These teachers recognise the conflict between religious beliefs and evolutionary theory and try to manage this divide by "constructing mental models incorporating selected elements of evolutionary theory with a biblical understanding of creation" (Meadows, *et al.,* 2000). The Muslim teachers will of necessity build their own models of evolutionary theory with the interpretation of creation from the Koran.

Farhad highlights this when he describes himself as a creationist and goes on to add that: "Although in my own mind, in my belief system there's already "mix-ups" going in my mind where this artificial selection comes in but with us we're going to believe that even with artificial selection if the knowledge was not put into your head you wouldn't be able to do it because your belief can come only from God." Farzhana explains her belief as: "Look for me as a Muslim I believe that man has not evolved that we were created. Every creation that has gone through- God created. Farhana explains the "big bang theory" is mentioned in the Koran and this becomes a relevant point to teach from.

Catherine manages the conflict and she explains the belief of the learners as: "their belief is the thing that they are grounded in and have been brought up with and that they hold onto. I don't want to pull that out from under them". Catherine clarifies her belief that man has not evolved as the chimpanzee and other animals have but that God breathed life into man. This account of creation is "special creation" (Scott, 2000). Carmen clarifies her mental model of evolution and creation as: "I believe that the book of Genesis, I don't believe the book of Genesis is how man was created, I believe that the Bible was written before we had any of these discoveries of the various fossils that have been found for the development of man and I believe that it is definitely a place for spirituality and a place for religion but I don't believe Adam and Eve was there and that now suddenly we developed". Yes I believe that God made us as we are now I just believe that it didn't take Him 24 hours to do so. Charlene describes the model that she has of evolution and creation by explaining that she believes that God created man but that He did it through evolutionary principles.
To summarise, one Christian teacher avoids the conflict and one Muslim teacher is disturbed by the conflict. Three Christian teachers and three Muslim teachers manage the conflict.

4.3.4 Border crossing

Table five below summarises the border crossings (Aikenhead, 1996) experienced by the Christian and the Muslim teachers.

Table 6: Types of Border crossing (Aikenhead,1996) experienced by teachers

Pseudonym	Type of school	Christian (denomination) / Muslim	Border crossing smooth, manageable, hazardous or impossible
Christine	Government	Christian Reformed	impossible
Farhad	Government	Muslim	hazardous
Farhzana	Government	Muslim	hazardous
Farhana	Muslim	Muslim	hazardous
Catherine	Christian	Christian Pentecostal	hazardous
Fazhila	Muslim	Muslim	manageable
Charlene	Government	Christian Reformed	smooth
Carmen	Christian	Christian Methodist	Smooth

Aikenhead (1996) suggests that children cross science borders when moving from home to school. Border crossing occurs when the everyday science experiences or worldviews of students are different from those experienced or expected in school science. The border crossings that students experience could then be described as being smooth, manageable, hazardous or impossible. In this study, teachers with strong religious beliefs are expected to cross borders when they teach evolution. Border crossings can be described as smooth, manageable, hazardous or impossible depending on the degree of difficulty experienced by the teacher when making that crossing.

The border crossings of teachers with strong religious beliefs who refuse to teach evolution or who sabotage their teaching of evolution can be described as being *impossible*. Teachers who emphasize the importance of learning evolution to pass examinations even when the content of evolution being taught is contradictory to their religious beliefs experience *hazardous* border crossings. *Managed* border crossings are experienced by teachers who have the misconception that acceptance of evolution is contradictory for a religious person. These teachers may tell teach learners evolutionary theory without mentioning religion. *Smooth* border crossings would be experienced by these teachers with strong religious beliefs when they their religious beliefs and the content they teach in “evolution” coincide.

Christine felt outraged that she is expected to teach something that is clearly contradictory to her religious beliefs. She argues that she is being forced to teach evolution therefore she tells learners to learn about the theory so that they can defend their faith. She teaches learners about the hoaxes that were presented to the scientific community, namely the "Piltdown man". She also rushes through the content matter on evolution. Border crossing for her would be described as impossible.

Farhad stated that: "saying one thing the wrong way can take you out of the fold of belief because you're questioning something the wrong way". Thus when he teaches he advises learners to preface their writing and explanations by stating that "evolutionists state that….".The use of these words indicates that border crossing for him is hazardous. Farhzana tells the learners in her class that: "this is not your belief and this is not my belief but this is what scientists have come up with and this is what I put forward as their theories". She also experiences border crossings that are hazardous. Farhana is a creationist thus she also experiences border crossings that are hazardous. She says that: what I emphasize in the class why we don't believe in the theory why we ... what are the flaws in the theory. I try to bring that in a lot". Catherine also experiences border crossings that are hazardous. She states that: "I don't see man as an animal that merely evolved".

The transition that Fazhila undergoes when crossing science borders would be manageable since she believes that man has evolved and says: "I also believe that man; according to Koran human beings were present on the earth. It is written that people of that time, they were quite tall more than 10 feet as compared with being a human being. That time people were quite tall but now the average height is less than 6 feet. Man has changed".

Charlene and Carmen both experience border crossings that are smooth when they teach evolution. Charlene claims that she is comfortable with the content in the topic "evolution". She explains that: "my faith provides me with a reason to teach evolution". Carmen states that: "I don't believe the book of Genesis is how man was created; I believe that the Bible was written before we had any of these discoveries of the various fossils that have been found for the development of man".

To sum up one Christian teacher experienced border crossing that is impossible. Four Muslim teachers and one Christian teacher experience border crossings that are hazardous. The border crossings of two of the Christian teachers can be described as smooth.

4.4 Difficulties experienced by teachers

Farhad teaches in a public school in a predominantly Muslim area in Gauteng. The suburb has just two high schools. When the topic of evolution was introduced to the Life Sciences syllabus in 2008 a pamphlet was distributed to homes in the area informing parents that their children are learning about evolution and that this is against Islamic principles. He explains that: “It was attacking the school as such and the teacher but without mentioning the school’s name”. Since both he and the other Life Sciences teacher is Muslim, he viewed it as a personal attack since the authors could have approached him to discuss this with him. He also told of an occasion when he arranged for learners to visit Maropeng and a parent (who is also a teacher at the school) refused to allow his son to go since he believed it was “haraam”, a term used by Muslims to indicate that something is forbidden or prohibited by your faith as a Muslim. This pressure from the community of teachers not to teach evolution or to teach creationism in science is similar to the situation in America (Branch & Scott, 2007; NTSA position statement, 2003)

Both Farhad and Farhana claimed that by including evolution in the Life Sciences syllabus many Muslim learners were refusing to do Life Sciences as a subject to Grade 12. This correlates with research by McKeachie, *et al.* (2002) who noted that the negative attitudes of students affect their willingness to learn, and their learning success so much so that a high proportion of students who do not believe in evolution drop out of evolution courses, or fail it, and are less motivated. Farhana also had learners in her class who felt that since they were in a Muslim school they shouldn’t be taught or tested on this topic. Both she and Fazhila had learners who refused to attend Life Science classes whilst the topic of evolution was being taught. They both requested the Principal to intervene and explain to these learners that this section was going to be examined in the final examination. After much negotiation the learners returned to class.

Carmen had to advise a learner not to take Life Sciences as a subject from Grade 10 because during a class discussion in a Grade 9 she taught about the evolution of the horse. This was in response to a question another learner had asked that stimulated a class discussion. The learner took this information home and her father was upset enough to come to the school and raise the issue with the teacher. Although she had support from the school and the principal, the advice she gave the parent was that this section is in the Life Science syllabus and that perhaps the parent should ensure that the learner did not do Life Sciences. She believes that the problem arose because the child is from a “fundamentalist church”. Research done by Blackwell *et al.* (2003) and McKeachie, *et al.*(2002) indicated that students have strong biases against evolution because of their religious beliefs.

Fazhila explained that in the Muslim school they are taught to follow the Koran totally and according to the Koran "there is no such thing like evolution". Later during the interview she stated that: "here I have to be diplomatic because I also believe that man, according to Koran, human beings were present on the earth. But according to my academic knowledge I will go with the theories (evolution) that there are because I have to teach". From this response I got the impression that she had to guard against her academic knowledge in what she had to say because she taught at a Muslim school. This apprehension of voicing her beliefs due to the controversy is reflected in research done by Moore and Kraemer (2005) as well as Meadows*et al.*, (2000)

Farhzana raised another difficulty in that she had the content knowledge to teach the previous syllabus but that she didn't have the same confidence in the content knowledge she had to teach evolution. She also stated that: "I sincerely believe that there is a Creator and I cannot tie the two. I cannot now change my religious beliefs and expect the concept of evolution to overtake my mind. I am a firm believer in my faith". This led her to teaching the content but without a "passion" or "enthusiasm" for teaching this topic. Her lack of belief in evolutionary theory has an impact on her teaching (Aguillard, 1999; Trani, 2004; Rutledge & Mitchell 2002).

Catherine teaches at a Christian school situated in the Church grounds. She explained that learners at the school are entrenched in Christianity. They are raised with the creation story and the backdrop to her teaching is Christianity so she says that: "anything I teach them that comes from outside of that framework will be new and foreign and you get a reaction". The most important principle to her is that she doesn't want to "shake a child's faith". Together with her personal convictions another factor that is learners are upset, parents get upset and this impacts on her relationships both at school and at church when evolution is taught to learners. This is similar to the pressure being placed on some teachers in some American classrooms. Their response is to include "creation science" alternatives to "evolution" (Branch & Scott, 2007; Clough, 1994; Sharpes & Peramas, 2006).

Charlene discussed that whenever learners hear the word "evolution" they shut down because it's not in their world, not part of their belief system. Christine experienced difficulties from a personal perspective when she explained that she felt she was being forced to teach evolution and that evolution contradicted her religious belief. Research by Aguillard (1999) Stears (2006) and Abrie (2010) verifies her stance as a "Creationist" who experiences difficulties when teaching evolution.

4.5 Strategies used by teachers to avoid conflict

All the teachers interviewed informed their learners that evolution is in the syllabus and that they had to learn it so that they could pass the Life Sciences (paper 2) examination. A common strategy used by the teachers is to tell learners to learn about evolution so that they could debate or argue Creationism from a position of knowledge and not ignorance. One of the Muslim teachers also apprised learners of the fact that the rest of society was not Muslim and that they needed to empower themselves with this different knowledge. Another strategy used by certain teachers is to tell learners that this "belief" was neither theirs nor the learners but was the "belief of some scientists".

Farhad outlined the strategies he used and explained to Muslim learners that by using the phrase: "evolutionists say that" to preface their answers they were protecting their faith. He also informed prospective Life Science learners that if they wanted to pursue a medical degree that they could do Physical Science or Life Sciences and could choose whether they wanted to do both.

Charlene and Farhana also introduced the section of evolution by relating to the faith system of the different learners. By so doing, these teachers sought to bring in values or a section from the Bible or Koran to make it relevant to evolution. Carmen and Farhzana also taught the science and told learners that it was up to them whether or not to believe it. A relevant point mentioned by Catherine is that the faith of the learners was important and that she did not want to deny learners their faith. But in so doing she also taught learners that they were gaps in the fossil record.

However Christine also taught learners that all the scientist's "stories" made sense and that as soon as another "story" came up the theories change. During the interview Carmen objected to the word "belief" being used and asked me to replace the word with "spirituality". This is relevant to her strategy of teaching evolution since she teaches from a perspective that religious belief and science are two separate entities. Fazhila also taught the proofs and theories as fact and told learners that they it was up to them whether they believed it or not but that these were the scientific truths.

4.6 Conclusion

In this chapter I explained how the data I got from the interviews with the teachers was analysed. I presented the results in four tables in relation to the analytical frameworks used and in answer to the research questions posed. In the next chapter I will summarise the results and will discuss the research process.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

Evolution was introduced to the Life Sciences curriculum for Grade 12 in 2008. The importance of this topic in the curriculum is reflected by the assessment since it comprises of 25% of the Grade 12 National Senior Certificated examination (Department of Education, 2007). The new framework for the subject Life Sciences now introduces "evolution" to Grade 10 learners with the remainder of the topic being taught in Grade 11 and Grade 12. Evolution of man is still being taught in Grade 12.

During various meetings with other Life Science teachers during discussion about results from Grade 12 examinations there is often mention of the various difficulties faced by teachers when they teach evolution. Of particular interest to me was the manner in which teachers both Christian and Muslim with strong religious beliefs, taught evolution.

The aim of this research was to gain insight into the teaching of evolution by teachers who have strong religious beliefs. One of the research questions answered during the study was to identify the viewpoints of teachers with strong religious beliefs about creation and evolution. This was answered when the beliefs of the teachers were categorized according to Scott's (2000) creation / evolution continuum. The second research question was to investigate how teachers with strong religious beliefs teach evolution. This was answered during the interviews with teachers. Barbour (2000) proposed four possible responses that could be used to describe the relationship between science and religion of teachers with strong religious beliefs. These responses were used to describe the manner in which these teachers teach evolution. The third research question was to explore the different ways in which teachers manage the conflict of science and faith when teaching evolution. Meadows,*et al.* (2000) propose a model of beliefs about religion and beliefs about evolution. This model was used to explain how teachers are able to manage the conflict of science and faith when they teach evolution.

The final research question was to establish the difficulties that are faced by some teachers with strong religious beliefs when they teach evolution. These were provided during the interviews with teachers when they outlined their personal difficulties and the various pressures placed on them by learners, parents and members of the community in which they taught. Teachers experienced border crossings that are smooth, manageable, hazardous or

impossible when they teach evolution depending on the degree of difficulty experienced by the teacher when making the crossing from religious belief to evolutionary theory.

5.2 Summary of the findings

Researchers have noted that perceptions exist amongst students that evolutionary theory contradicts the existence of God (Blackwell*et al.*, 2003; McKeachie,*et al.*, 2002).Five of the eight teachers interviewed indicated that their religious belief conflicts with the theory of evolution. These five teachers of which three are Muslim and two are Christian acknowledged that they are creationists. Venter (2008) identified a group of people who believe in creationism. Of the main strands, categorized he identified Old Earth creationists and Young Earth creationists. Young Earth creationists will attack the scientific validity of evolution. The teachers who are creationist sabotage their teaching of evolution. This is consistent with research done by Aguillard (1999). Two of the creationist teachers also teach learners known hoaxes of fossilized remains and focus on these hoaxes rather than the known fossil finds. One of the Christian teachers interviewed is a Young Earth creationist. She teaches creationism and teaches evolution superficially. This correlates with research done by Clough (1994) that teachers harbour the misconception that the origin of life is synonymous with evolution theory. She also teaches learners that the meaning of the word "theory" is "guess" or "speculation" rather than the scientific meaning of the word.A suggestion made by Clough (1994) to diminish student's resistance to evolution is to clarify the scientific meaning of the word "theory".

The teachers interviewed also experienced varying influences from the parents, learners and members of the community they teach in when they teach evolution. All the Muslim teachers interviewed in this study teach and live in predominantly Muslim communities. An extreme example of pressure from the community was when a pamphlet was distributed to parents in a predominantly Muslim suburb that their children were being taught evolution at this school and that this was contrary to what is stated in the Koran. Pressure placed on teachers not to teach evolution is not limited to the Muslim respondents since two of the Christian teachers also provided examples of parents who objected to their children being taught evolutionary theory. Two Muslim teachers described that learners walked out of their lessons when evolution was being taught. This occurred at the Muslim schools and not the secular schools. This is reminiscent of the "evolution wars" that Branch and Scott (2007) refer to. The difference being that in America there is also the on-going courtroom war against evolution being taught in the classroom. In this scenario however the "evolution war" is with members of the community, parents and learners.

Five of the teachers interviewed managed the conflict with science and faith when they taught evolution. These teachers have also composed "mental models" (Meadows*et al.*,2000) by using certain parts of evolutionary theory in conjunction with the understanding of creation from the Koran or Bible. Aguillard (1999), Trani (2004) and Rutledge and Mitchell (2002) noted from their research that when teachers teach without any belief in evolutionary theory their teaching is affected and they spend less time teaching evolution.

Four of the teachers interviewed, three Muslim and one Christian teacher experienced border crossings that were hazardous. They preceded the teaching of evolution by stating that this was not their belief but that learners needed to learn about evolutionary theory to pass the examinations. These teachers taught the theory of evolution but also taught creationism. Research done by Aguilllard (1999) indicates a group of teachers who believe that the teaching time allocated to creationism should be the same as that for evolution. The teachers that taught creationism in this study did not refer to the amount of time that they spent teaching creationism but indicated that in the teaching of evolutionary theory they made references to creationism. Aguillard (1999) identified a group of teachers who believed that creationism has a valid scientific foundation.

Three of the teachers interviewed encouraged learners to learn about evolution so that their knowledge could empower them to argue for creationism. In this regard the curriculum is clear:

> "Evolution accounts for life's unity and diversity, and operates through natural selection. As a result of natural selection, some individuals survive and reproduce, while others die or fail to reproduce."
>
> Overall introduction to Life Sciences Grades 10-12 (2007)

One of the teachers interviewed acknowledged the different religious accounts of creationism.In this manner she teaches science and encourages learners to learn the science. Her approach to teaching can be compared to one of the suggestions made by Matthews (2001) where learners are encouraged to discuss and consider their own ideas about the origin of life. She did not experience any influences from the community when she taught evolution but she teaches at a secular school, in a religiously diverse community.

5.3 Research limitations and importance of the study

The limitations of my study are that the sample of teachers chosen was small and taken only from one province. I only used one source of data, namely interviews for this study. Document analysis of the preparation of lessons did not provide usable data. Muslim communities in the different provinces in South Africa differ. Certain communities appear to be more orthodox than others. A more comprehensive study would encompass the different provinces in South Africa. The teachers selected are teaching in different suburbs and their experiences with the community, both parents and learners differ. Had they all been from one suburb their experiences could have been comparable. The qualifications of the teachers were not accounted for and differed from teacher to teacher. The lack of training experienced by some teachers is related to the qualification of these teachers. Another factor not considered is the number of years the teacher may have taught. Teachers that have recently qualified would have greater exposure to evolutionary theory in their training.

Nevertheless the value of this research study is that it is indicative of the actual difficulties experienced by teachers with strong religious beliefs. The experience of the teachers with the teaching of the content of evolution and the misconceptions that they experience provides information that is relevant and valuable to the Department of Education, institutions of higher learning and the various non-government organisations involved in the training of teachers and in-service teachers. The experience of the teachers with learners, parents and members of the community provides information that is relevant and valuable to the Department of Education in their communication with the media.

In completing this study I have become more aware of the different perspectives of learners in my classroom. If adults with strong religious beliefs are experiencing this much difficulty when reconciling evolutionary theory with creation, then the religious beliefs of learners need to be handled with even more care.

5.4 Recommendations

The recommendations for the Department of Education and the different non-government organisations that are involved in the in-service training of Life Science teachers with the topic of “evolution” are as follows:

1. Training should be directed so that teachers know about the nature of science before they teach evolution
2. Training should be specific so that certain teachers are targeted, for example those teachers who lack training but with specific qualifications should be grouped together

3. Resources should be made available to learners via the internet or the television that could facilitate the learning of evolution should teachers be unwilling or incapable of teaching evolution
4. There needs to be an attempt to educate parents and the community of the need to learn about evolution in a non-threatening manner.

Recommendations to teachers with strong religious beliefs when they teach evolution:

1. Although there are immense time constraints to finishing the syllabus the views of learners need to be considered and valued
2. Prepare lessons so that accurate Science is being taught irrespective of religious beliefs
3. Teach evolution and not creationism. There is mention of alternative explanations to evolution in the curriculum. Teach these only in context so that learners are prepared for the Life Sciences at tertiary level.

5.5 Suggestions for future research

Eight teachers were interviewed and even though I sought out devout teachers at religious schools and secular schools there could have been teachers of other faithselsewhere with more interesting stories. A bigger sample of respondents is needed as well as respondents from a larger geographical area. Observations of the lessons taught will prove more useful in establishing how teachers teach evolution rather than attempting to obtain lesson preparation and establishing which resources teachers are using. Also interviewing teachers when they are currently teaching evolution would be more useful than interviewing the teachers three months after they have taught evolution. This would allow to the researcher to draw more reliable conclusions on the impact of the teacher's beliefs when they teach evolution.

Learners could provide information that would provide insights that would help the researcher to determine the extent to which the religious beliefs of their teachers influence their teaching of evolution. Learners could be surveyed or provided with questionnaires to establish this.

5.6 Conclusions

It is apparent from this study that some teachers with strong religious beliefs experience difficulties when they teach evolution. Creationism seems to be taught in the Life Science classroom in most of the religious schools involved in this study with only one school being

the exception. This is of concern but the reality is that parents are paying the fees and are able to dictate the way in which evolution is taught to their children.

The daily interactions of teachers with strong religious beliefs with learners, parents and members of the community that these teachers teach in, need to be considered. These teachers are "on the frontlines of the evolution wars" (Branch and Scott, 2007: 53) and their voices need to be acknowledged. But while recognizing the difficulties faced by the teachers care should also be exercised that evolution is taught as an important principle in Biology. Dobzhansky (1973) highlighted this importance when he described biology as "intellectually the most satisfying and inspiring science" and that teaching biology without evolution is merely teaching learners an accumulation of facts.

Clough (1994) suggests that one of the ways to diminish students' resistance to evolution is to acknowledge that the scientific community needs to decide what good science is and not the general public. Thus in order for South African students to hold their own in the greater scientific community good science needs to taught. Teachers, not the general public, should decide the scientific content of their lessons. However, teachers should also be suitably educated to distinguish between what scientific content is and what it is not and to recognise that the teaching of evolution is necessary.

Many of the concerns raised are beyond the scope of this small study and further research would need to be undertaken to address these concerns.

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Appendix 1

Interview Schedule

Introduction

Hello I'm Charmaine, we spoke the other day about the research that I am doing about the teaching of evolution. Thank you for giving me the opportunity to ask you some questions. I am particularly interested in teacher's views on the teaching of evolution and their own religious belief and anything else you can tell me about the manner and resources you use in the teaching of evolution. As I said the other day, I can promise that your name will never be linked with anything you say; you will remain completely anonymous. I'd like to tape record our conversation although I don't want your name to appear on the tape. Taping our discussion means that I don't have to take a lot of notes which speeds up the process and ensures that I have an accurate record of what we say. No one except me will hear the tape.

	Main Questions	Possible Probe
	Introductory questions	
1.	How long have you been teaching Life Sciences/ Biology?	
2.	Do you enjoy teaching Life Sciences/Biology?	
3.	Describe the best teaching situation that you have ever experienced.	
4.	What are the most important values that you want to develop in your students?	
5.	The curriculum has changed for grade 10 in2009, and will change for grade 11 in 2010. The present grade 12 syllabus was taught for the first time in 2008 and will change in 2011. (Show teacher addendum with the change in curriculum) What do you think about the change in the curriculum relating to biodiversity, change and continuity?	Ask for clarification. Can you explain (what the respondent has answered)?
6.	There have been certain sections that have been included for the first time in the grade 12 curriculum last year (from the addendum). Do you think "evolution" should be taught at high school?	When you taught grade 12 with the previous curriculum, you did not teach evolution. Do you think a grade 12 learner needs to learn about "evolution"?
7.	What is your religion?	What denomination do you belong to? (Christian teachers only)
8. 9.	Does your faith/religious belief influence your teaching of evolution? In what way does your faith/religious belief influence your teaching of evolution?	How do you decide what to teach and what not to teach when you teach evolution?
10.	What is your belief about how man originated?	
11.	There are certain belief systems that state that God created life as it is now. What do you believe? To what extent does your religious belief coincide with evolution?	Ask for clarification. Could you explain what you said?
12.	What do you teach learners about the origins of	Silent probe

	man? Is this in conflict with your faith?	Overt encouragement. E.g. okay, oh, uh-huh If no ask for clarification. If yes ask how do you deal with this conflict?
13.	How do you teach evolution?	What resources do you use when you teach evolution? Ask for clarification, if necessary.
14.	If a learner in your class does not believe that evolution has occurred what strategy would you suggest to the learner to prepare them for the final examination?	What strategy would you suggest to this learner when you teach evolution?
15. 16.	What do you teach about the origin of species? Is this in conflict with your faith?	Silent probe Overt encouragement. E.g. okay, oh, uh-huh If no ask for clarification. If yes ask how do you deal with this conflict?

Thank you for answering these questions. I really appreciate the information that you have provided me with. I have given you my contact details, so if you have any queries about this study please do contact me.

Appendix 2
ADDENDUM FOR QUESTION ON THE CHANGES IN THE CURRICULUM

OLD GR 10 CURRICULUM	CURRENT GR 10 CURRICULUM
TAUGHT FROM 2006	TAUGHT IN 2009
Diversity, change and continuity Defining Biodiversity, various taxonomic groups, classification of organisms, five kingdom classification Defining Biodiversity and conservation. Adaptation and survival – natural selection, change over time, Significance and value of biodiversity – energy flow, adaptations, providing resources and relationships, sustainable development Threats to biodiversity Consumption, Habitat reduction, Habitat fragmentation, Habitat destruction, Global warming, alien vegetation, Fire Define Parasitism and diseases	**Diversity, change and continuity** Classification schemes Main grouping of living organisms Fossil formation Fossil methods of dating Life history relationship to climate and geological events Cambrian explosion (Pre + cambian + post) Mass extinctions Key events in life's history Key events in life's history Life forms become more similar to present life-forms

CURRENT GR 12 CURRICULUM	NEW GR 12 CURRICULUM
TAUGHT IN 2008	TO BE TAUGHT IN 2011
BIODIVERSITY, CHANGE AND CONTINUITY Early theories of evolution Jean Baptiste de Lamarck (1744 – 1829) Charles Darwin (1809-1882) Variation as an explanation for evolution The geological time scale Evidence for evolution, Mass Extinctions Trends in human development Search for the cradle of humankind	EVOLUTION Evolution as a scientific theory and not just a hypothesis. The difference between hypothesis and theory. **Darwin's theory of evolution by natural selection** **Formation of new species** Speciation as a mechanism for producing new species. Geographic speciation due to isolation **Human evolution** **Evolution in present times** **Alternative explanations**

CURRENT GR 11 CURRICULUM	NEW GR 11 CURRICULUM
TAUGHT FROM 2007	TO BE TAUGHT IN 2010
Diversity, change and continuity Population studies Defining population, species Geometric and Logistic growth curves Outline factors that influence population growth, fluctuations of populations, Analysing age and gender graphs Determining population size, Extinction of species, red data listing Etology – social behaviour of animals Population management: Biodiversity of plants and animals Threats to Biodiversity Natural resources HIV/AIDS	**Plant and animal diversity in South Africa** • Bryophytes • Pterophytes • Gymnosperms and angiosperms Concept of phylum as illustrated by a body plan. The Animal kingdom • Phylum Porifera • Phylum Cnidaria • Phylum Platyhelminthes: • Phylum Annelida • Phylum Chordata A very brief comparative analysis of the body plans of the different phyla is required. It should be explained in the context of evolution.
	Modifications of basic body plans Select ONE of the following for further study: Mammal forelimb: basic plan modified for digging (mole), flying (bat), fast running (horse), swimming (seal) and climbing trees (monkey). OR Modification of feeding or locomotory appendages of insects for eating different foods OR Modification of flowers such as orchids (or any other suitable group) for specific pollinators. **Biogeography** Diversity exists within continents, but is even more striking on different landmasses and islands.

Appendix 3

Information Sheet for Grade 12 Life Science Educators in schools where interviews will take place

Research study on the manner in which teachers with religious beliefs teach evolution

My name is Charmaine Pillay. I am a Masters of Education student at the University of the Witwatersrand.

The study involves the identifying the manner in which "evolution" is taught by teachers with strong religious beliefs. I would need to ascertain how the religious beliefs of teachers influence their teaching.

I would like to invite you to participate in the interviews. During the interview I will ask you questions about your religious beliefs and questions on how you teach evolution.

There are no known risks from being in this study. However I hope that others may benefit in the future from what we learn as a result of this study. If you agree to take part in my study, I'd like to make it clear that your participation is entirely voluntary, no negative consequences will result from your participation, and all information will be treated with confidentiality. A copy of the research report will be sent to you, if you want to receive a copy. If you do choose to participate, you may decline to answer any questions, and you may withdraw from the study at any time. When the research is written I will use fictitious names to protect your identity.

Thank you.

Charmaine Pillay

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Appendix 4

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Informed Consent Form for Grade 12 Life Science Educators: Interviews

Research study on the manner in which teachers with religious beliefs teach evolution

I, _____ consent to being interviewed in the study conducted by Mrs Charmaine Pillay, a student at the University of the Witwatersrand for her research on the teaching of evolution by teachers with religious beliefs. I realise that no negative consequences will result from my participation in this study, and that the study is being conducted for purposes of improving the teaching of Life Sciences in our schools. I also understand that I have the right to review the transcripts made of our conversations before these are used for analysis if I so choose. I can delete or amend any material or retract or revise any of my remarks. I acknowledge that everything I say will be kept confidential by the interviewer and that I will only be identified by a pseudonym in the transcript. In addition, any persons I refer to in the interview will be kept confidential. I participate voluntarily and understand that I may withdraw from the study at any time.

Verbatim quotes from me may be used in the research report, but they will be reported so that my identity is anonymous. Any specific individual I refer to will be given pseudonyms. I understand that the results of the study may be published, but my identity will be anonymous.

Name: _____

Signature: _____

Date: _____

Audiorecording

I further consent to audio-recordings to be made of the interview. I understand I have the right to review the transcripts made from these audiorecordings before these are used for analysis if I so choose. I can delete or amend any material or retract or revise any of my remarks. Everything I say will be kept confidential by the interviewer. I will only be identified by a pseudonym in the transcript. In addition, any persons I refer to in the interview will be kept confidential.

Name: _____

Signature: _____

Date: _____

Appendix 5

Information Sheet for Principals in schools where interviews will take place with Grade 12 Life Science Educators

Research study on the manner in which teachers with religious beliefs teach evolution

My name is Charmaine Pillay. I am a Masters of Education student at the University of the Witwatersrand.

I am carrying out a study that investigates the manner in which teachers with religious beliefs teach evolution. I would need to ascertain how the religious beliefs of teachers influence their teaching

I would like to invite your school to participate in the interviews. Your participation means that you will allow me to interview Grade 12 Life Science educators (pending their consent) about the teaching of evolution.

There are no known risks from being in this study, and you will not benefit personally. However I hope that others may benefit in the future from what we learn as a result of this study. If you agree to take part in my study, I'd like to make it clear that your participation is entirely voluntary, no negative consequences will result from your participation, and all information will be treated with confidentiality. If you do choose to participate, your Grade 12 Life Science educators may decline to answer any questions, and they may withdraw from the study at any time. When the research is reported on, I will use fictitious names to protect your identity.

Thank you.

Charmaine Pillay

CONTACT DETAILS:
Email: charmaine.pillay@hotmail.com

POSTAL ADDRESS:
P.O. Box 2906
Edenvale
1610

Appendix 6

Email: charmaine.pillay@hotmail.com
POSTAL ADDRESS:
P.O. Box 2906
Edenvale
1610

Informed Consent Form for Principals: Interviews

Research study on the manner in which teachers with religious beliefs teach evolution

I, _____ consent to my Grade 12 educator/s being interviewed in the study conducted by Mrs Charmaine Pillay, a student at the University of the Witwatersrand for her research on the teaching of evolution by teachers with strong religious beliefs. I realise that no negative consequences will result from my participation in this study, and that the study is being conducted for purposes of improving the teaching of Life Sciences in our schools. I also understand that they have the right to review the transcripts made of their conversations before these are used for analysis if they so choose. They can delete or amend any material or retract or revise any of their remarks. Everything they say will be kept confidential by the interviewer. They will only be identified by a pseudonym in the transcript. In addition, any persons they refer to in the interview will be kept confidential. My school participates voluntarily and understand that my school may withdraw from the study at any time.

Verbatim quotes from the educators may be used in the research report, but they will be reported so that their identity is anonymous. Any specific individual they may refer to will be given pseudonyms. I understand that the results of the study may be published, but the school and the educators' identity will be anonymous.

Name: _____

Signature: _____

Date: _____

Audiorecording

I further consent to audio-recordings to be made of the interview. I understand that the educators have the right to review the transcripts made from these audiorecordings before these are used for analysis if I so choose. The educators can delete or amend any material or retract or revise any of my remarks. Everything they say will be kept confidential by the

interviewer. They will only be identified by a pseudonym in the transcript. In addition, any persons that they may refer to in the interview will be kept confidential.

Name: _____

Signature: _____

Date: _____

Appendix 7

Wits School of Education

27 St Andrews Road, Parktown, Johannesburg, 2193 • Private Bag 3, Wits 2050, South Africa
Tel: +27 11 717-3007 • Fax: +27 11 717-3009 • E-mail: enquiries@educ.wits.ac.za • Website: www.wits.ac.za

STUDENT NUMBER: 416510
Protocol: 2009ECE99

30 August 2009

Ms. Charmaine Pillay
P O Box 2906
EDENVALE
1610

Dear Ms. Pillay

Application for Ethics Clearance: Master of Education

The Ethics Committee in Education of the Faculty of Humanities, acting on behalf of the Senate has considered your application for ethics clearance for your proposal entitled:

The difficulties faced by some teachers with strong religious beliefs when they teach evolution

The following comments were made:

Since a number of the questions are ethically sensitive i.e. “what is your religion” these may be considered objectionable. To get around this, the participants need to be given the questions in advance and told that any of the questions they feel uncomfortable with they may decline to answer.

Recommendation:

Can be cleared once the above have been attended to

The supervisor needs to inform the office of the Wits School of Education’s Research Ethics Committee that the above mentioned amendments have been made to the proposal for ethics clearance to be granted.

Yours sincerely

MatsieMabeta
Wits School of Education

Cc Supervisor: Ms. M Doidge (via email)