Deconstructing Controversial Topics in the Science Classroom:

Evolution in a Catholic Secondary School

By:

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Abstract

Despite the topic of evolution being regarded as highly controversial, it has been implemented in the Ontario curriculum. This study explores how Catholic Ontario high school Biology teachers are approaching this sensitive topic in their classroom. This research study was conducted using a qualitative research approach comprising of a literature review and semi-structured interviews. Throughout the analysis process, four main themes emerged: the level of confidence teachers have about the evolution curriculum and their personal beliefs on evolution as a controversy both affect how these teachers teach the topic, teachers’ beliefs about the importance of creating a safe, open space for discussions of evolution and finally, strategies for encouraging students to express their opinion on controversial topics. These findings create implications for not only students and teachers but teacher education programs, which could be held accountable for not successfully preparing teachers. Finally, the study suggests areas for further research as well as specific recommendations.

Key Words: controversy, evolution, Catholic school, biology
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Chapter One: Introduction

1.0 Research Context and Problem

The publication of Charles Darwin’s book *On the Origin of Species* in 1859 was revolutionary. His concept of evolution by natural selection openly opposed Christianity and its ideology that God created the first human beings. His theory that humans and apes descended from a common ancestor was discussed in his book *The Descent of Man* in 1871 but was widely criticised at the time of publication. Despite this, Darwin’s theory later gained momentum and became the beginning of a new era of discoveries, debates and theories of the origin of humanity (Overy, 1997).

Over many decades, there have been countless arguments supporting both creationism and evolution. The Catholic Church has published multiple documents in hopes to address the theory of evolution and how it could be explained through a creationist lens. In 1950, Pope Pius XII stated there was no teaching of the Church that prohibited people from believing the theory of the evolution of the human body. However, he mentions that the Catholic faith firmly believes that the human soul is created directly by God (Pius XII, 1950).

Catholic creationists are not forbidden but rather encouraged to understand and critically analyze the theory of evolution. Therefore, it is concerning that Catholic high school biology teachers in North America may be shying away from the discussion of evolution in their classroom in fear of controversy (Berkman & Plutzer, 2011). This is worrisome because these biology teachers play a critical role in developing public consensus about science (Berkman, 2015). Berkman and Plutzer (2011) found that out of 926 teachers studied in Pennsylvania, 60% avoided validating evolution in order to circumvent controversy. The students taught by these teachers may not have sufficient scientific literacy to critically analyze and form an educated
opinion on any controversial issue they are presented with in the future simply because they lack the skills.

Unlike the Ontario public school system, all Ontario Catholic high school students must meet the Ontario Catholic School Graduate Expectations prior to receiving their diploma at the end of their high school career. These expectations state that the graduates must be discerning believers, effective communicators, reflective, creative and holistic thinkers, self-directed, responsible, lifelong learners, collaborative contributors, caring family members and responsible citizens.

All Catholic high school teachers are required to prepare their students to meet these expectations, regardless of their subject expertise (Preparation for Teaching in Catholic Schools, 2012). Therefore, Catholic biology high school teachers have to efficiently teach the curriculum, prepare their students to meet the graduate expectations and encourage students to think critically on topics society deems to be controversial.

While briefly touched upon in the grade 9 Earth and Space Science unit, the Ontario curriculum introduces the topic of evolution in Grade 11 biology as an independent unit. Three big ideas are covered throughout the unit: evolution is the biological change in a species over time, there is an abundance of evidence that supports this theory, and the technology that humans have created to mimic natural selection has had environmental implications (Ontario ministry of education, 2008). The curriculum is designed in such a way where students can critically analyze the evidence for evolution and natural selection and make references to animals or plant characteristics they can see today. For example, when microevolution is discussed in the curriculum, students look at how the sickle-cell alleles are linked to malaria resistance. While
perhaps not directly, Ontario Catholic biology teachers are encouraging their students to be reflective, creative and holistic thinkers through the evolution unit.

Ontario Catholic teachers have a slightly greater responsibility when it comes to preparing their students for graduation. While evolution is still a controversial topic both in and out of the classroom, these teachers are required to not only follow the curriculum but to teach in such a way as to not offend their students. Understanding how Ontario Catholic teachers are managing this is the primary focus of this study.

1.1 Purpose of the Study

The purpose of this study was to explore the experiences of Ontario Catholic secondary biology teachers on delivering the evolution content in the curriculum. Considering the vast variation in every biology teacher’s religious views and science education, it is not unusual to assume a great discrepancy in how each of them teaches evolution in the classroom (Hermann, 2012). Despite these discrepancies, all Catholic biology teachers should be preparing their students to become knowledgeable, active Christians in their local church communities (Institute for Catholic Education, 2012). To explore this topic, I interviewed a small sample of Catholic high school biology teachers about: their confidence in their knowledge of the evolution curriculum, their perceptions on the place of faith in science and science education, and factors that supported or hindered them in their ability to teach about evolution in a respectful yet scientifically literate way.

1.2 Research Questions

The central question that guided this study was: What are Ontario Catholic secondary biology teachers’ experiences of delivering the evolution content in the curriculum? Sub-questions that further guided this study included:
• How confident are these teachers in their knowledge of the evolution curriculum?
• What are these teacher’s perceptions on the place of faith in science and science education?
• What kind of scientific and religious backgrounds do they have and how does this reportedly affect their teaching in this area?
• What factors support and hinder these teachers in their ability to teach about evolution in a respectful yet scientifically literate way?

1.3 Reflexive Positioning Statement

Controversial issues are one of the few things that divide every society. Communities that once were united and harmonious become jaded and separated when a controversial topic is cultivated. Being brought up in a Catholic household that had staunch preconceived beliefs shaped my own belief about many worldly issues before I had even reached high school. It was not until I realized my passion for science where I had to learn to understand and accept the vast differences between creationism and evolution.

As a graduate of the Ontario Catholic school system, I was never exposed to controversial debates in my high school science classroom. It was not because it was forbidden but rather because the teachers never invited or encouraged us to do so. Even during grade 11 biology, where I was first introduced to the evolution unit, I never considered the topic to be so controversial in society. I was more focused on the discoveries than the hypotheses of Darwin since that is what I considered them to be: hypotheses. The idea of ‘ape into man’ was not discussed in my classroom nor did we go into depth about Darwin’s personal struggles in releasing his theory to a largely Christian public. The topic was simply taught as a part of history
which explained how new species arose from pre-existing species, with the exception of Homo sapiens.

My teachers all had a similar teaching style of ‘stand and deliver’ and my classes were not a very open environment. None of the students questioned our teachers let alone the curriculum and what evolution should mean for us as Catholics. Looking back now, I do think that the topic was not covered in the manner it should have been in order to prepare creationist students to enter a world where there are people who not only have different beliefs but completely reject the creationist point of view. If we had been taught to understand and live with people who believe in the evolution of man, I believe we would spend less of our time convincing one another of our beliefs and society would be more harmonious. However, there will always be extremists on either side which prevent such a world from existing.

Being a believer of the Catholic faith and having a vocation to be a science teacher has interested me in understanding how Catholic biology teachers have succeeded in teaching the topic of evolution while being respectful of contrasting viewpoints.

1.4 Overview

In order to answer the above research questions, I conducted a qualitative research study that used purposeful sampling to interview two Ontario Catholic high school biology teachers about their experiences on delivering the evolution content in the curriculum. In Chapter Two, I review the literature in the areas of integrating the creationist view while teaching the Ontario evolution curriculum. In Chapter Three, I describe my research methodology. In Chapter Four, I present my research findings and discuss their relevance to the existing research literature. Finally, in Chapter Five, I explain the implications of the research findings in a broad and narrow sense, make recommendations and suggest areas for further research.
Chapter Two: Literature Review

2.0 Introduction

In this chapter I review research literature in the areas of the relationship between religion and evolution, teacher pedagogies for teaching about evolution, and findings on teaching controversial discussions in the classroom. More specifically, I review research that discusses the affiliation between diverse religions and evolution and the interpretation of creationism in the high school biology classroom. While broadly discussing the relationship between religion and evolution, I focus more explicitly to studies on the Christian faith and the theory of evolution. Next, I review findings on teacher knowledge of the theories of evolution and consider how this, and pressure from external factors, impacts the strategies used to teach about evolution. Finally, I outline how teachers can foster debates on controversial topics in the classroom.

2.1 Evolution and Religion

The initial debate of the theory of evolution was sparked by its opposing assertion that God did not create man. Naturally, any religion that believes that man was made in the image of God is going to reject this theory or argue it is not true in its entirety. Looking at these religions in different regions around the world has proved to be beneficial when considering the relationship between religion and evolution. To understand the global controversy of the extent to which evolution is taught in the science classroom, one must first acknowledge that, in almost any country, the centre of focus is the religious demographic (Hermann, 2013). Since there is an obvious relationship between religion and evolution, one can argue that the teaching of creationism is supported by people of faith who reject the theory of evolution. This poses a problem for teachers who teach creationism in a public school since in some countries, like the United States, it is against the law to do so (Edwards vs. Aguillard; Moore, 2008). Despite this, there was an increase in the number of biology teachers teaching creationism in North America
from the early 1990s to the early 2000s (Moore and Kraemer, 2005). The degree to which people of faith reject the theory of evolution varies among different religions and sub religions. For example, BouJaoude et al. (2011) found fluctuating acceptance of evolution among three Muslim sects - Sunni, Shiite and Druze - in Lebanon and Egypt where Sunni students, in both areas, were more influenced by religious beliefs and more likely to reject evolution. Unlike public schools, however, some Christian faith-based schools are encouraged, by administration or pressured by parents, to teach Young Earth creationism, a theory which discounts Darwinian evolution and states that the Earth is only 6,000 -10,000 years old (Meadows, 2007).

Since there are multiple creation stories from Christianity, Islamic and Hinduism (Leeming & Leeming, 1994; Scott, 2004), teaching creationism in the public science classroom becomes a controversy in itself. Moore (2008) found that more than 80% of his 1,465 student sample population at the University of Minnesota, were presented only the Biblical account of Creation in the public school they attended. In his study, other religion’s perspectives on creation were either disregarded or touched upon briefly. This poses a problem since it could be argued that these students, who are not attending a faith-based school, are being exposed to the teachings of Christianity.

As of 2008, the population of Christians worldwide was 33.32% (Martin, 2010). It is interesting to note that despite being fundamentally the same, the major denominations of the Christian faith (Roman Catholic, Protestant, Orthodox and Anglicans) were found to vary in their acceptance of the theory of evolution (Martin, 2010). Protestant students in Northern Ireland were found to more likely oppose evolution than Catholic students (Francis and Greer, 1999; Murphy et al. 2010). The controversy of teaching evolution has been especially prominent in the United States. Despite being a component of the science curriculum, exposure to evolution is
inconsistent among students across the United States (Chapman et al., 2014). These inconsistencies among religions and nations imply there is a misconception of the theory of evolution among the global population which has yet to be rectified.

2.2 Teaching about Evolution in K-12 Schools

In an ideal world, all biology teachers would be objective experts in biology. However, teacher knowledge, pedagogical styles and personal beliefs will naturally influence the way in which these teachers present the topic of evolution to their students.

2.2.1 Teacher’s knowledge of Evolution

Despite there being minimal debates on the acceptance of evolution among biologists (Moore 2010; Nelson & Skehan 2010) it has been identified that there is a clear lack of understanding of the theory of evolution and sometimes even the fundamental nature of science among biology teachers required to teach evolution (Trani, 2004). A 90-question survey administered by Trani (2004) was given to teachers in Oregon to test their knowledge of these theories. The results concluded that 16% of biology teachers were either not presenting the topic of evolution or were presenting it with inaccuracies. A similar study conducted by Moore and Kraemer (2005) found that only one-third of biology teachers in Minnesota agreed that their undergraduate classes prepared them to teach evolution. These findings suggest that the level of exposure and understanding of the theory of evolution is drastically different from teacher to teacher. Berkman and Plutzer (2011) found that if teachers are not assertive in their knowledge of the theory of evolution, the tendency is to avoid the topic altogether. Combined with a lack of knowledge of the theory itself, pressure from administration and parents could further negatively impact a teacher’s ability to successfully teach evolution in the classroom (Trani, 2004).
2.2.2 Pressure to avoid teaching evolution

One of the most difficult issues any teacher has to deal with is pressure from external factors, including administration and parents, on their subject matter or their teaching style. This has been something that has been going on for decades as shown by a study done by Zimmerman (1987). His study looked at the opinions of high school biology teachers on teaching the evolution-creationism controversy. Zimmerman (1987) found that around 10% of these teachers experienced some form of pressure from pro-creationism external sources to either omit evolution from their curriculum or add a creation component. It is clear if this issue has been resolved even twenty years later since a study done by Moore and Kraemer (2005) in Minnesota public high schools showed that there was a drastic increase (19% to 48%) of teachers who described being pressured to avoid teaching evolution from 1995 to 2003. Similarly, Asghar et al. (2007) conducted a study that analyzed the misconceptions of Canadian pre-service elementary teachers. Their study determined there were several reasons why biology teachers were avoiding the topic of evolution. Many of these reasons were linked back to pressure from administration and parents to avoid the topic or give minimal attention to it. These studies make it clear that pressure from external factors can negatively impact a biology teacher’s pedagogical choices.

Another factor that could be contributing to an absence of the discussion of the evolution controversy could be the vast differences among biology teachers’ scientific literacy. Some of these teachers have insufficient knowledge to welcome, let alone uphold debates on creationism and evolution in their classroom. Since the Canadian government and school boards have tried to streamline the education of the Ontario high school science teachers as much as they can – a B.Sc and teaching certificate - they, along with society, have to accept that despite this, they are
still going to get teachers with diverse backgrounds and experiences. These diversities will ultimately affect the way in which each teacher teaches evolution in the classroom.

**2.2.3 Teacher practices for teaching about evolution.**

Although research has found that some preservice teachers preferred not to teach evolution and teach non-scientific views instead (Blank & Andersen, 1997; Cleaves & Toplis, 2007; Kahyaoglu, 2013), Veal and Kubasko (2003) found that preservice teachers had more integrative approaches to teaching evolution than experienced teachers. An interesting study done by Borgerding et al. (2015) looked at how Ohio preservice teachers were approaching the instruction of evolution and what factors influenced their instruction practices. The three participants, while having common ideas about teaching and learning, approached the instruction of evolution in different ways. In her instruction, one participant’s goal was to get students to merely understand the content rather than accept it. Her strategy was to first and foremost address common misconceptions about evolution including the age of the universe, the relationship between apes and humans and the history of living organisms. Another participant, however, had a background in evolutionary research and thus, his instruction strategies were influenced by his personal experiences. The last participant’s goal, unlike the first, was to convince students about evolution. She did this by using real-world applications to prove the existence of evolution. While all three preservice teachers had different instructional approaches to teaching evolution, the study did not measure if they successful in their attaining their goals.

There are many ways teachers can approach teaching the topic of evolution. Studies have proven that these approaches will depend on the attitudes and experiences of the individual teacher (Borgerding et al., 2015, Veal and Kubasko, 2003) and there is currently no effective method in streamlining how evolution is taught in the classroom.
2.2.4 Teacher concerns about evolution as a controversy

In the same study, Borgerding et al. (2015) looked at the individual concerns of the three participants regarding evolution as a controversy. The main concern these preservice teachers shared was making the students feel uncomfortable. Other concerns included student’s maturity level, students feeling pressured to ‘believe’ a certain way, and not providing a good disclaimer/introduction. Moreover, teacher’s self-concerns, including having a lack of knowledge on the topic or not being familiar with the details to why the topic is a controversy, will lead to many more concerns about teaching of evolution (Berkman & Plutzer, 2011; Trani, 2004). If the apprehensions are enough, teachers result in avoiding the topic altogether or teaching it as if there is no controversy (Berkman & Plutzer, 2011). In order to address these concerns, science teachers must first become knowledgeable about the theory of evolution, through means such as professional development, and secondly, be prepared to foster controversial discussions in the classroom (Berkman & Plutzer, 2011; Lusk & Weinberg, 1994).

2.3 Controversial Issues in the Secondary Classroom

There is no one consensus as to whether the classroom is the place to discuss society’s controversial issues. However, when controversial issues are implemented into the curriculum, it is up to the teacher’s discretion whether or not to discuss the topic as a controversy or to simply teach what is mandated. It is not easy to initiate classroom debates on ‘heated’ topics. For one, talking about controversial topics has been found to create awkward silences or students giving insensitive responses (Lusk & Weinberg, 1994). Scott and Branch (2003) developed criteria, as part of a research study, for deciding which controversies should be taught in the classroom. Firstly, they suggested that the controversy should be of interest to the students and should also be more scientific based rather than morally or religiously based. Second, the controversy should
be primarily scientific rather than moral, social or religious. The third and fourth criterions suggested that there be recourses available to compare both sides equally and that these resources be of equal quality. But perhaps the most important criterion suggested was that the controversy must be understandable by the students. Using the criteria they created, they evaluated whether the evolution controversy should be taught in the classroom. They found that while it does satisfy criterion one and three, it fails to satisfy the other three criterions. However, it is important to note that the study conducted by Scott and Branch (2003) was looking at teaching this controversy in public schools. According to their criterion, the evolution controversy would satisfy criterion two in Catholic schools. Naturally, these criteria cannot realistically be used by teachers on a daily basis; however, if a teacher does choose to foster a controversial discussion in their classroom, it is extremely important for that teacher to know what role they should play during the discussion. Kelly (1986) found four potential roles a teacher could take during this time: exclusive neutrality, exclusive partially, neutral impartiality and committed impartiality. While there are advantages and disadvantages of each, Kelly (1986) found that the most appropriate role teachers should assume during controversial topics is the committed impartiality. This teacher would be able to discuss controversial issues without undermining the integrity of either side and encourage students to do the same through their example. Of course, this is the most ideal role for a teacher during a controversial class discussion but, not all teachers are able to do so. However, it can be assumed that the teacher will take on one of the roles mentioned above by Kelly (1986) which can prove somewhat beneficial in encouraging future discussions of topics with a controversial nature.

2.3.1 Benefits of an open classroom

An open classroom has been defined to be a place where students are encouraged to
participate in controversial discussions and where diverse opinions are respected (Godfrey & Grayman, 2014). Several benefits were attributed to open classrooms. A study done by Godfrey and Grayman (2014) showed that an open classroom climate positively resulted in student’s socio-political efficacy both in and outside the classroom, and positively influenced the development of their critical consciousness. Rothenberg (1989) found that students in open classrooms were more independent than students in traditional classrooms. Moreover, these students were also found to be less conforming and worked better with others.

While teachers face many challenges with inviting controversial topics into the classroom, the benefits of doing so can be the difference between encouraging the development of a student who will become an active, positive contributor to society to one who will not.

2.3 Conclusion

In this literature review I examined research related to the relationship between religion and evolution, teacher pedagogy of evolution and the challenges/outcomes of inviting controversial discussions in the classroom. This review clearly demonstrates that there are several factors that challenge teachers from being able to successfully teach evolution as a controversial topic in their classroom. Firstly, an ambiguous understanding of the theory itself may contribute to the lack of confidence teachers have to encourage students to critically analyze both evolution and creationism. Furthermore, pressure from external factors such as administration and parents can impact the teacher’s role and even the content that they teach. However, positive outcomes have been attributed to having an open classroom where controversial topics, such as evolution, are welcomed. Teachers who take on this challenge and foster controversial debates in the classroom need to be knowledgeable in the subject matter and be willing to take an impartial role.
In my own study, I explored how educators are able to successfully teach evolution as a controversial topic. With my findings, I provide a better understanding of how these teachers were able to prepare students to critically analyze societal issues. These skills not only encourage students to become rational voices in their communities but provide teachers with a good reason to accept the challenge of fostering controversial discussions in their classrooms.
Chapter Three: Research Methodology

3.0 Introduction

In this Chapter I describe the research methodology. I begin by reviewing the methodological decisions I made about the research procedures and the main instrument I used for data collection. I then focus more specifically on participant sampling and the sampling criteria I used for recruitment. I proceed to explain how the data was analyzed and reviewed and address the ethical considerations pertinent to my study. Lastly, I identify the various methodological limitations of the study while also speaking to the strengths.

3.1 Research Approach & Procedures

This research study was conducted using a qualitative research approach comprising of a literature review of existing research relevant to the research purpose and questions of the study, as well as semi-structured interviews with two teachers.

Creswell (2002) looked at the basic differences between qualitative and quantitative research. He described quantitative research to be more closed since variables of the study need to be defined in advanced. He considered qualitative research to be more open-ended since the researcher leaves the participants with the opportunity to provide their own accounts relevant to the research topic. An issue with the open-ended questions in a qualitative study involves the researcher being somewhat dependent on the participant’s willingness to offer in-depth responses. While restricted answers can be expected to a certain degree, the researcher is still able to draw conclusions based on content and conversation analysis (Jackson II et al., 2007).

Qualitative research has generally been known as a means of research that aims to uncover and understand the experiences and perceptions of participants (Hiatt, 1986 qtd. in Conrad and Serlin, 2011; Jackson II et al., 2007; Scruggs et al., 2007). Due to its fluid and
personal nature, qualitative research has often been used in education and health care (Conrad & Serlin, 2011; Orb et al. 2000) in order to discover beneficial information based upon the personal experiences of participants working in these sectors. For example, in their study, Orb et al., 2000 found that conducting qualitative research in clinics allowed patients and staff to feel significant and safe once a good rapport was established. The feeling of safety was extremely important because it permitted the participants to speak up about issues they were facing within the clinic. The information received from qualitative research is sometimes considered ‘rich’ because the researcher will get more than what he/she is looking for (Jackson II et al., 2007).

Due to the nature of my research purpose and questions, a qualitative research study was the most appropriate for me. It allowed me to give my participants the opportunity to go beyond the questions I asked and expand on experiences they might have been reminded of during the interview process. In this way, I designed my questions to be more open-ended in order to understand the perspectives, challenges and successes of Biology teachers who have taught the evolution curriculum.

3.2 Instruments of Data Collection

The primary instrument for data collection used in this study was the semi-structured interview protocol. A semi-structured interview is described as a guided conversation where the researcher has a set of questions or topics that they use in order to initiate the interview (Miles & Gilbert, 2005). After this, the conversation is free flowing and will likely change between participants (Fylan, 2005 qtd. in Miles & Gilbert, 2005). This is unlike a structured interview where each participant is asked the same questions in the same order from a predetermined list of questions. In a semi-structured interview, the researcher can switch from question to question...
depending on how the interview unfolds since it caters to each participant differently (Fylan, 2005 qtd. in Miles and Gilbert, 2005).

The main benefit of using a semi-structured interview protocol is the ability to allow new ideas and viewpoints to develop freely (Aira et al., 2003). The guide is structured to some degree in order to allow for key talking points and themes to be addressed during the interview. Since participants are encouraged to share their personal experiences and feelings about the questions asked, researchers can draw conclusions not only on the answers given but the participants’ behaviour and attitude towards the questions as well (Aira et al., 2003).

For the purpose of my study, I organized my interview guide (located in Appendix B) to include questions that produced responses unique to each participant. Examples of my questions include:

- How does your identity as a Catholic influence your professional identity as a biology teacher?
- What is your perception on the place of faith in science and science education?
- What are some challenges you have experienced when differentiating creationism and evolution to your students?

3.3 Participants

As in any research study, the development of the study sample can be regarded as one of the most important steps (Fylan, 2005 qtd. in Miles & Gilbert, 2005). It is important to choose a sample of participants that, while sharing commonalities to the research question, bring a certain level of diversity to the study; however, because this is a very small study, participant homogeneity will be emphasized. Below, I review the sampling criteria I created for participant recruitment, and the methodology used for teacher recruitment. I have also included a section
wherein I will introduce each of the participants.

3.3.1 Sampling Criteria

For this study, the following criterion was used for teacher participants:

1. Teachers will be working in either the Dufferin-Peel Catholic District School Board or the Toronto Catholic District School Board.

2. Teachers will have a minimum 3 years working in a Catholic school.

3. Teachers will have a minimum 3 years teaching Grade 11 biology, including the evolution unit.

Since this study was limited to a small, selective sample, participants worked in one of the local Catholic school boards in order to maintain a geographical focus and for convenience purposes. Teacher participants also had a minimum 3 years working in a Catholic school and were comfortable within a Catholic school community. Moreover, these teacher participants had a minimum 3 years’ experience teaching grade 11 biology, specifically, the evolution unit.

3.3.2 Sampling procedures

When deciding upon the best sampling procedure, it is important for researchers to first understand the various sampling methods and then pick the one that caters best to their research purpose. For example, Coyne (1997) completed a literature review where she found that the terms ‘selective’, ‘purposeful’ and ‘theoretical’ sampling were being used interchangeably despite having different definitions. Selective sampling is said to be choosing participants based on an initial set of criteria at the beginning of the study (Sandelowski et. al., 1992 in Coyne, 1997). Purposeful sampling looks for participants who have experiences relevant to the needs of the study. Participants with particular knowledge are sought out in order to provide deeper insights into the study (Morse, 1991 in Coyne, 1997). Lastly, theoretical sampling chooses
participants based on developing classifications and emerging theories (Coyne, 1997).

For the purpose of my study, I used a combination of selective and purposeful sampling. The sampling procedure was selective in that participants shared the criteria developed previously. Since my study sample was small, the sampling procedure was purposeful in that I chose participants who have experiences (Catholic biology teacher) specific to the needs of my study. I also utilized convenience sampling by finding participants through my existing connections as a pre-service teacher and as an individual who completed both elementary and secondary education within the Greater Toronto Area. Lastly, I used snowball sampling by asking participants to refer other teachers who fit the criteria and might be interested in partaking in the study (Noy, 2007).

### 3.3.3 Participant Bios

Two participants were interviewed for this study. The first was Scarlett. Scarlett is a Catholic science teacher in the Dufferin-Peel Catholic District School Board and received her teaching certificate in 1996. She has close to fifteen years of experience teaching the grade 11 and 12 Biology course and the evolution unit. Scarlett has never taught outside the province or in a public school before and considers herself an occasionally practicing Catholic. She values being able to teach in a Catholic school because of the sense of community. The second participant was Zach. Zach is also a teacher employed by the Dufferin-Peel Catholic District School Board and received his teaching certificate in 2003. He has been teaching grades 11 and 12 Biology for the past ten years, including the evolution unit. Zach, too, has never taught outside the province or in a public school before. He described himself as an active Catholic growing up but admitted that as an adult, his faith is sometimes challenged. Zach also, however, values working for a Catholic board because of the sense of community.
3.4 Data Analysis

Qualitative data analysis focuses on the content of the information given by a participant or the inferred underlying meaning of that same information in order to draw reasonable conclusions about the topic (Tesch, 1990). Despite having that information presented in various forms in this study through the use of semi-structured interviews, qualitative data analysis ‘goes beyond merely counting words to examining language intensely for the purpose of classifying large amounts of text into an efficient number of categories that represent similar meanings’ (Hsieh & Shannon, 2005).

Wolcott (1994) suggests there are three ways in which data can be presented: description, where the researcher draws conclusions based upon the participants answers and stories; analysis, where the researcher can build upon the answers given to make educated assumptions relating to key themes of the study; and finally, interpretation, where - like the analysis category - the researcher can isolate certain responses and draw inferences based on those. Wolcott (1994) claims the interpretation category to be the starting and ending point for qualitative inquiry. Despite the different ways in which the data can be presented, all of them follow a similar outline of identifying key patterns, assigning codes to these patterns and finally categorizing them into major themes of the study (Wolcott, 1994).

One important aspect of data analysis is the “data reduction” whereby the researcher has the analytical choice which parts of the data they would like to code, patterns they want to emphasize and experiences they want to share (Miles & Huberman, 1994). Here, it is up to the researcher’s discretion to determine how the data fits with the study’s purpose and answers the research questions. Moreover, data that provides strong support to conclusions drawn in the final research paper is likely to be chosen as key findings during the study. During the analysis of my
data, I transcribed my interviews, coded the data and identified common themes from the data collected. I then categorized my coded data according to major themes I identified and discuss the significance of it.

3.5 Ethical Review Procedures

As with any fieldwork study, there are certain ethical issues that must be considered prior to completing the study (Miles, Huberman, & Saldana, 2014). Depending on what type of study it is, the ethical dilemmas that might arise can vary. For example, in my qualitative research study, I had to be aware of the ethical implications surrounding informed consent. To overcome a possible ethical issue, participants were asked to sign a consent letter (Appendix A) giving their consent to be interviewed as well as audio-recorded. This consent letter provided an overview of the study, and specified expectations of participation (one 60 minute semi-structured interview). Moreover, Miles, Huberman and Saldana (2014) discuss the importance of research integrity and quality and developing a trusting relationship with participants. Along similar lines, they also discuss ethical implications of use and misuse of results. I also assigned each participant with a pseudonym allowing their identities to remain confidential and removed any identifying markers that would be related to their schools or students. To avoid ethical implications surrounding the use and misuse of results, all data (audio recordings) will be stored on my password protected computer/laptop/phone and will be destroyed after 5 years (Miles, Huberman and Saldana, 2014). Given the nature of my topic, there are no known risks to participation. I re-assured my participants, throughout the interview, that they could refrain from answering any questions that made them feel uncomfortable.

All researchers should be aware of the four main ethical issues that surround researchers interacting with participants. These ethical issues include: *non-maleficence* where the researcher
should refrain from causing physical harm to participants, *beneficence*, suggesting that the research should be carried out for a positive purpose, *autonomy* where participant’s values and decisions should be respected and lastly, *justice* where both, researchers and participants will be treated equally (Flick, 2009). In addition to these ethical considerations, Miles, Huberman and Saldana (2014) discuss the potential ethical dilemmas surrounding an imbalance of power. However, since I am a student who conducted interviews with established teachers, there was a minimized power difference between the participant (interviewee) and myself (interviewer).

3.6 Methodological Limitations and Strengths

One of the best qualities of a strong research study is the absence of limitations on study sample (Hackshaw, 2008). The biggest limitation of my study was the restriction associated with the number of teachers I could interview. Since my study sample was small, I could not, therefore, make generalizations about the patterns and relationships I found among my participants. However, the strength in having a more focused participant pool is the opportunity to understand, in more depth, the particular successes of individual teacher strategies of teaching the evolution curriculum.

Another methodological limitation associated with my study was the restriction of the criteria of the participants (Hackshaw, 2008). For the purpose of my study, the only participants of interests were classroom teachers. This was a drawback because there could be important information about my study found by conducting interviews with students or parents. Furthermore, conducting classroom observations would allow me, as the researcher, to witness what strategies my participants were using to successfully teach the evolution curriculum. However, the quality of information I got from interviewing teachers surpassed that from a survey. It also allowed for opportunities to hear personal experiences of these teachers and get an
in-depth understanding about what matters most to them with it comes to their faith and the evolution curriculum. Moreover, it gave the teachers the chance to reflect on their practices and to articulate how they conceptualize this topic in theory and in practice.

3.7 Conclusion: Brief Overview and Preview

In this Chapter, I discussed the research methodology. I began by reviewing ways in which a qualitative approach was the best method for my specific research and procedure. I then described the instrument I chose for my data collection to be interviews. I described in detail the semi-structured interview protocol I used and the importance of it. I then identified the participants of the study by listing the sampling criteria, the sampling procedures in which I found my participants and lastly, providing a brief biography of each participant. After this, I discussed the means of data analysis I used in order to synthesize the information I received during the interviews into patterns and categories. I considered a number of ethical implications including informed consent, research integrity and quality, use and misuse of results and the right to withdraw and suggested ways to address these possible implications. Lastly, I described the limitations of the study including a small sample size, while also acknowledging the strengths of those limitations, getting an in-depth understanding of participant’s experiences and perceptions. In the next Chapter, I report on the findings of the research.
Chapter Four: Research Findings

4.0 Chapter Introduction

In Chapter 1, I identified the main research question of my study to be: what are Ontario Catholic secondary biology teachers’ experiences of delivering the evolution content in the curriculum? In Chapter 2, I examined existing literature in three major areas: the relationship between religion and evolution, teacher pedagogy of evolution and the challenges/outcomes of inviting controversial discussions in the classroom. In Chapter 3, I described the research methodology and the instrument I chose for my data collection to be interviews. In this Chapter I present and discuss the findings that emerged during the analysis of the data collected during the interview process. Throughout the analysis, I was mindful of my research question. In the discussion that follows, I make inferences to the participants’ experiences and draw connections to the literature reviewed in Chapter 2. The findings have been organized into four main themes:

1. The level of confidence teachers have about the evolution curriculum affects how they teach the topic
2. Personal beliefs on evolution as a controversy
3. Teachers’ beliefs about the importance of creating a safe, open space for discussions of evolution
4. Strategies for encouraging students to express their opinion on controversial topics

Some themes have been further categorized into sub-themes for which a more in-depth analysis will be made. For each theme and sub-theme, I will describe it, report on the data and present the importance of the theme in light of the existing literature. Lastly, I summarize my findings and transition to Chapter 5, where I will make recommendations for further research.
4.1 The Level of Confidence Teachers Have about the Evolution Curriculum Affects How They Teach Evolution in the Classroom

Between both participants, there was an obvious contrast when discussing their level of comfort with the Ontario evolution curriculum. While both declared themselves to be familiar with the curriculum, their varied responses to the question “what is your personal comfort level with the evolution curriculum?” can be used to argue otherwise and thereby make inferences as to the level of importance they may give this topic in their classroom.

When interviewing Zach, there was a recognizable passion when he spoke about the evolution curriculum: “evolution is my favourite unit to do, partially because of the controversy. I didn’t take an evolution degree; I did a degree in human biology. I had courses in evolution but since I’ve graduated, that’s been my, probably, primary interest in biology.” His passion for the topic extended past his education and personal interest to methods he uses in the classroom:

If we read non-fiction or something like that, it’s about evolution. And because a lot of that has to deal with the fight between evolutionists and fundamentalists with religious opinions, I get a lot of background from evolutionists on how to counter the arguments made by fundamentalists. And so I feel very confident.

It is evident that Zach’s personal passion for the topic of evolution plays a major role in how he teaches the topic in his classroom. Incorporating arguments from both opposing sides, Zach is able to cultivate critical thinking among his students by allowing them to decide for themselves which argument they see as truth.

Scarlett, on the other hand, was very brief in her response to my question about the level of comfort she had with the curriculum, stating that “I think I’m pretty comfortable with it.” Scarlett’s much less enthusiastic response and the use of the word ‘pretty’ made it evident that
she was not as confident with the evolution curriculum as she may have wanted to seem. Through subsequent questions it was clear that her focus as a biology teacher was on delivering the curriculum content rather than addressing evolution as a controversy. Due to her lack of confidence, Scarlett’s tendency was to address the controversy as it came up rather than introduce the topic as an opportunity to encourage students to express their viewpoints and ask questions.

The drastic difference in responses supported the findings from the study done by Moore and Kraemer (2005) discussed in Chapter 2. This study suggested that the level of exposure to the theory of evolution is drastically different from teacher to teacher, and, therefore, not only affects the level of comfort teachers have with teaching this topic but how they teach it in their classroom as well. Moreover, as found by Berkman and Plutzer (2011), if teachers do not feel knowledgeable about the topic of evolution, they are more likely to avoid the topic all together. In Ontario, since the evolution unit is a mandatory part of the curriculum, teachers uncomfortable with the topic would more likely deliver the material while shutting down any possibility for a debate or explanation as to why it might be a controversy in society. Furthermore, Asghar et al. (2007) found that some teachers avoid discussing the controversy of evolution since they were worried about offending people’s religious beliefs or interfering with student’s beliefs.

Therefore, in light of these studies and the participant’s experience, it is extremely important for teachers to be knowledgeable and confident when teaching not just the evolution unit, but any controversial topic in the classroom.

4.2 Personal Beliefs about Evolution as a Controversy

The topic of evolution is not without controversy as many teachers, students and members of the general society will state. Throughout the interview process, I kept a conscious
eye out for any questions or discussions that might have led to offense being taken by the participants. Naturally, to understand how these teachers have been teaching the evolution curriculum in a Catholic school, it was important to know not only their attitudes towards evolution as a controversy but their student’s attitudes as well.

### 4.2.1 Teacher attitude towards evolution as a controversy

Both participants were in agreement that the topic of evolution is only a controversy because of the lack of information and understanding many people have. Scarlett stated her view:

I think this is where there is a huge misconception, like in the outside world. Evolution and Catholicism are not in conflict with each other at all… there’s nothing that I’m teaching in evolution – there’s nothing in evolution that goes against the Catholic religion. It’s a non-issue and so people talk about it as if it’s an issue but it’s – in reality it’s not an issue.

Scarlett clearly believes that the theory of evolution should not be a controversy at all. She frequently mentioned the words ‘misinformation’ and ‘misunderstood,’ implying throughout there is no real debate when it comes to the two seemingly opposed sides. Zach agreed along similar lines, stating that:

[s]o then you hear the common objections ‘oh, it’s just a theory’ and then I tell them what a scientific theory is and say ‘well gravity is just a theory for why we’re not falling off the Earth. And the germ theory shows why you get the flu etc. Etc. So why are we debating this theory and not everything else?

Zach’s approach of defining what a theory is and his use of practical examples helps his students gain a better insight into why he believes evolution should not be a controversy. It was also interesting to note that during the interview, I referred to the theory of evolution as being my
opinion to which Zach corrected me, saying “you have to remember it’s not necessarily your opinion, it’s the evidence.” Correcting me during the interview only illuminated his confidence in the topic and provided insight as to what he expects from his students.

Overall, both participants demonstrated a high level of desire to prove that the theory of evolution should not be a controversial topic in schools. While both my participants held this attitude, Trani (2004) found that there is a clear lack of understanding of the theory of evolution and sometimes even the fundamental nature of science among Biology teachers in Oregon who are required to teach evolution. Remembering that all teachers come from a diverse background, this could have easily been found in the present study should it have been extended to include more participants.

4.2.2 Student attitude towards the theory of evolution from a teacher’s perspective

While my study was limited in that I was not able to interview students directly, I was interested to hear the attitudes of my participants’ students on the theory of evolution from the participant’s perspective. This information would prove valuable to my study since it would only provide more insight into the reality of my participant’s classroom.

From Zach’s experience, he reflected on a time where a student challenged him on the theory of evolution because of her personal, family beliefs:

And so she challenged me on this and she goes ‘but sir, the earth was created in 7 days and is only 6000 years old.’ And I thought she was joking at first because she’s a very intelligent student and so I tried to draw this out of her and she’s very outgoing and she says her father is a 7th day Adventist and they are Young Earth Creationists and she is very dead set saying ‘yes, the Earth is only 6000 years old.’
He went on to describe the experience of debating with her to be challenging but, moreover, he was “trying to instil in her that she can have her faith and she can look at evolution and understand that evolution is happening.” What this student’s experience proves is that the classroom is a very diverse place. Students will walk in having different cultural backgrounds and religious beliefs. How Zach described approaching the situation, reassuring her that she can have both her faith and see the truth in evolution seemed to be with sensitivity and respect. While doing this, he also encouraged her to critically analyze her viewpoint and communicate it effectively.

Scarlett had a similar experience with a student whom she described as “[believing] that all animals – yeah, that God created all of nature in its form ... as it is right now and that was it.” To which she said she replied “well that’s what maybe you’ve been taught but actually there’s evidence to show that’s not the case.” She described that by the end of the course the student seemed to be okay with the material because, as she argued, “when you actually look at, there’s nothing threatening there.” Scarlett was more candid then Zach, stating simply that the student’s belief was flawed because there was evidence to disprove it. Scarlett’s assumption that the student seemed to be okay with the material emphasizes that perhaps, more attention needed to be given to help the student articulate any concerns they might have still had after the course.

It is important to note the differences among not only these teacher’s attitudes on evolution but student’s as well. The differences found by Zach and Scarlett provide support to Martin (2010)’s finding that, despite being fundamentally the same (the belief in Jesus Christ), people from the major denominations of the Christian faith (Roman Catholic, Protestant, Orthodox and Anglicans) were found to vary in their acceptance of the theory of evolution. Moreover, there are other religions, such as Islam and Hinduism, who could see the evolution
content in the curriculum as controversial (Leeming & Leeming, 1994; Scott, 2004) and, as Zach stated, “we find that it’s not just Christians who are not opposed to Evolution, its other faiths as well.” Being in a Catholic school does not limit non-Christian students from attending. Both Zach and Scarlett expressed having non-Christian students raise issues about the evolution content as well.

4.3 Teachers’ Beliefs about the Importance of Creating a Safe, Open Space for Discussions of Evolution

The significance of this theme is to identify, through the examples of both participants, the downfalls that occur as the result of not having an open classroom where students feel safe to express their opinions about the topic of evolution. Zach mentioned a common problem teachers can have when trying to get all students to participate in controversial discussions in class. Based on his experience, he stated that “what I found is that the outgoing students, strong students, have no problem sharing their opinion but how do you get the quiet student to do it?” If students feel unsafe or that they will be judged by their fellow peers or teacher, they may be less likely to participate, as concluded by both participants. Moreover, Scarlett, when discussing student’s lack of expression on the topic of evolution, indicated that “I think people feel threatened for some reason.” She went on to discuss that this threatening feeling might come from a lack of understanding of the opposing side. Zach believes that it is up to the teacher to set the tone of the classroom as being ‘safe’ or a place where different opinions are welcomed. In his experience, if this is not done right from the beginning, students may not be willing to participate when asked later during the course. Scarlett also mentioned her strategy of letting students know that they are in a safe space in her classroom where judgement of someone’s opinion is not welcomed.
Another consequence, mentioned by both participants, of not having an open classroom is the fact that students might never be exposed to the reasons behind the other side of a controversy. For example, Zach stated that

I think, the earlier we teach evolution, the earlier we get it to students – like for example, that one student that was Young Earth creationist, her father instilled in her this creationism way before any biology teacher could explain evolution to her. So sometimes ideas are engrained or misconceptions are engrained very early so the earlier we teach them the better.

Zach’s experience with this one student was not unique. He mentioned that almost all his students who opposed the theory of evolution had already made up their mind without hearing the other side. Along similar lines, Scarlett confessed a challenge she experiences when students are not allowed to hear both sides of a controversy:

Even the most basic misunderstanding, which let’s say, even the older people, like the grandparents, have been like ‘oh! They’re teaching people came from monkeys.’ Like that is the most ignorant statement and you’re fighting against that because ... they tell their kids and they get to your class and they’re like ‘miss, so uh, do we really come from monkeys?’

Here, Scarlett shows how the consequences of not having an open classroom are many. Not only do students refuse to participate because they feel unsafe, but by not freely discussing topics, students run the risk of never having been exposed, in a proper manner, to the reasons people may have a different opinion than them. Being able to address these misconceptions in the classroom could stop the cycle of misinformation from generation to generation.
4.4 Strategies for Encouraging Students to Express their Opinion on Controversial Topics

Using different pedagogical strategies in the classroom can encourage students to participate in discussion of sensitive topics. Both participants shed light on strategies that worked well for fostering a productive discussion on controversial topics in the classroom. Scarlett broadly suggested mentioning to the students that “we’re not here to judge each other personally; we’re here to share ideas.” Moreover, Scarlett suggested telling the students “at the end you can still, um, have your opinion but you should have an informed opinion based on different viewpoints.” Scarlett’s hope was to provide her students with all the facts from both points of view by addressing the controversy should anyone question it. During the interview it came up that she had hoped the course would speak for itself and she would not have to discuss the controversy in depth. On the other hand, Zach gave more specific strategies he used in the classroom, particularly during the evolution unit, to encourage discussion of the controversy.

Another thing I did recently is the quote activity. I provide the students with four different quotes, put four colours to them and I gave them four different coloured cue cards to match the colours on the screen. I say pick the quote that resonates with you, whether you agree with it strongly or disagree with it strongly, whatever one gives you the biggest reaction and write a quick-write opinion on it. [T]hen I said now everyone stand up and go around the room and trade cards.

Zach mentioned that students respond well to this activity since they are not put on the spot and asked to share their own opinion. Furthermore, it allows quiet or timid students’ opinions to be shared. Zach mentioned that the quotes he chooses vary from Young Earth creationists to evolutionists to atheists’ beliefs and therefore, can address all these viewpoints in one activity.
These strategies are important to implement in the classroom when discussing topics that may be controversial. Lusk and Weinberg (1994) found that controversial topics tend to create awkward silences or students giving insensitive responses, but by creating an activity around it, teachers can eliminate these problems. Zach’s unique activities strive to eliminate any ’awkward silences’ he might get in the classroom. Scarlett, however, did not mention the use of different activities to engage the students in discussion, but rather, is confident that the content will speak for itself. Furthermore, Kelly (1986) identified four potential roles a teacher could take during the discussion of controversial topics to be: exclusive neutrality, exclusive partially, neutral impartiality and committed impartiality. The study also showed that the most appropriate role teachers should assume during controversial topics is committed impartiality. This teacher would be able to discuss controversial issues without undermining the integrity of either side and encourage students to do the same through their example. In my interpretation, this is the role Zach has taken on as he describes:

I also tell them, before it starts, whatever side has the lowest representation, I’m going to join it myself. So I let them debate and I’ll interject points as well just to try to see if they can dig even deeper than their opinions. So that way if we can argue the other side you can defend your position better.

By allowing his students to understand that he was not expecting a ‘right’ answer and showing them that he could defend either side, helps his students feel more comfortable participating in a debate. The real test, he mentioned, was discovering if they can defend their positions as well as they think they can or discover that they are easily persuaded.

In my opinion, Scarlett takes on more of the exclusive neutrality role in her classroom. This role attempts to encourage students into accepting a particular position on a controversial
topic by giving less attention to the opposing view. It was very clear that she believes evolution should not at all be considered a controversy “It’s a non-issue and so people talk about it as if it’s an issue but it’s – in reality it’s not an issue… It’s not something to believe or not believe it – actually there’s scientific evidence that it is occurring”. Scarlett reacted with frustration during the questioning of evolution as a controversy. By this reaction, students would probably not be comfortable enough to bring up opposing views in her classroom.

It is clear from Zach’s experience, as well as the literature, that using different activities or pedagogical strategies in the classroom helps encourage students to participate in discussion on sensitive issues. The teacher’s roles can also either hinder or encourage this discussion as seen by the roles both Zach and Scarlett take in their classroom.

4.5 Conclusion

Throughout the analysis process, four main themes emerged. There were several levels to understanding how the participants I interviewed are teaching the evolution curriculum (and with self-reported success), but also how they were encouraging discussion of the controversial topic of evolution in their classroom. The data collected showed that the level of confidence teachers have about the evolution curriculum affects how they teach the topic. The more confidence they had, the more likely they were to foster discussions on why evolution is a controversy. Secondly, I found that both teachers had an assertive belief that evolution should not be regarded as a controversial topic. Furthermore, they believed that people, who believed that it was a controversy, were either misinformed or misunderstood the information provided. It was also significant to understand what the consequences would be if a teacher should not welcome healthy discussion or expression of opinions in the classroom. One major consequence would be rarely hearing the voices of timid or introverted students since they would be too scared to be
judged by their peers or teacher. Another consequence could result in the students not understanding why a topic is controversial. They might have only been exposed to one side of the debate and had not been giving the opportunity to hear the other side. These consequences are what led me to uncover strategies to encourage students to express their opinions on controversial topics.

A general strategy, mentioned by both participants, to involving all students in the classroom was concluded to be an invitation to participate. If this invitation was followed by a reassurance that the classroom is a safe place, students were more likely to engage in the discussion. The strategy that Zach used in his classroom, called ‘Quote Activity’, addressed the two main consequences noted above. Not only would all students be willing to participate since they would be sharing someone else’s opinion, but many opinions that might not have been shared have an equal opportunity of being expressed. Additionally, by incorporating multiple perspectives, from Young Earth creationists to evolutionists to atheists, students are exposed to all sides of the controversy. Scarlett’s approach addressed the consequence of students not being exposed to the opposing side to their belief on the controversy. She believed that the facts would speak for themselves and if a discussion did not naturally occur, it was not required.

My findings provided much insight into my central research question which was: What are Ontario Catholic secondary biology teachers’ experiences of delivering the evolution content in the curriculum? Experiences vary from teacher to teacher as found in the literature and my study. However, there are more effective ways to encourage students to think critically about societal controversies than others. In Chapter 5, I discuss broad and narrow implications for teachers and students, provide recommendations for classroom biology teachers on how to foster
discussion on the topic of evolution as a controversy and finally, suggest potential areas for further research.
Chapter Five: Conclusion

5.0 Introduction

In this Chapter, I discuss an overview of the key findings and their significance before looking at some implications of my study. Then, I make some recommendations for Catholic biology teachers and suggestions for future research.

5.1 Overview of Key Findings and their Significance

From my study, three key findings were discovered. Firstly, the level of teacher comfort with the evolution curriculum and their personal view of evolution as a controversy are both linked to how much focus these teachers give to addressing the controversy in their classroom. For example, Zach seemed extremely comfortable with the evolution curriculum and although he personally believed that evolution should not be a controversy, he gave much focus to both opposing viewpoints in his classroom. On the other hand, Scarlett appeared to be less comfortable with the curriculum but also had very strong beliefs that evolution should not be a controversy. However, she shied away from encouraging discussion on evolution as a controversy justifying this by assuming the content would speak for itself. When a discussion did arise about the issue, she made it very clear where she stood. The significance of this finding is to provide proof that if a teacher does not feel confident in the subject matter they are to teach, then students will only have superficial knowledge on that subject. Likewise, a teacher’s personal viewpoints can deter students from expressing their opposing viewpoints on the same topic in the classroom. This inhibits the students from developing their critical thinking skills when challenged on their beliefs outside the classroom.

Another key finding from the study was the discovery of two main consequences of not having an open Biology classroom. For this context, open means a place where students are
encouraged to participate in controversial discussions and where diverse opinions are respected. The first consequence was the issue of not hearing the voices of timid or introverted students.

Both participants stated that most students, even with an invitation from the teacher, are scared to express their individual beliefs or concerns in front of the class. Some have to believe they are in a safe environment to do so. The second consequence, noted by the participants, was the concern that students, prior to taking the Biology course, might have only been exposed to one opposing side of the evolutionary controversy. If the Biology class was not an open space, then students would not be able to freely discuss their existing views with one another and moreover, see that there are different ways to look at the same issue. The significance of this finding was to recognize that the Biology classroom needs to be an open space. The importance of an open classroom extends beyond students just feeling comfortable to students being able to have intellectual discussions with multiple viewpoints while respecting each other. These are life skills that students will take outside the classroom and into their personal lives.

Lastly, the third major finding that my study brought to light was strategies on how Biology teachers can create an open classroom. Both participants discussed the importance of inviting students to partake in classroom discussions. However, they also both noted that, when the discussion is on a sensitive topic, such as evolution, a platform needs to be set where the students are assured that they are in a safe, non-judgmental space. A teacher can do this by either simply stating it, as Scarlett did, or challenge both opposing sides, as Zach did. Another strategy teachers have is to use anonymous activities. Zach used the ‘Quote Activity’ where students wrote their personal viewpoint anonymously and traded with others. The benefits of this activity were many but more specifically, getting to share student's opinions that would have not been comfortable enough to share themselves. The significance of this finding is to suggest that there
are ways to overcome the consequences of not having an open Biology classroom as mentioned previously. Students may not always be willing to participate at first, but having a teacher cultivate a safe, open, classroom where sensitive topics can be shared respectfully, has proved to encourage students to participate.

5.2 Implications

In this section, I discuss possible implications of this research. First, I look at broad implications of the research that affect the educational community followed by narrow implications and interpret what these findings mean for my professional identity and practice.

5.2.1 Broad: The educational community

My findings suggest there are some implications for the broad educational community including teachers, teacher education programs, administration, parents and students. As mentioned previously, the level of confidence teachers have in their subject area affects how they teach that subject. This creates an implication for teacher education programs, for which it can be argued that these programs are failing to prepare teachers to successfully teach their courses with confidence. This lack of confidence teachers may have in the classroom can result in a ‘closed’ classroom where discussions with differences of opinions may not be welcomed. This ‘closed’ classroom then, creates an implication for students since they run the risk of missing an opportunity to develop their critical thinking skills through the discussion of sensitive topics such as evolution.

Encouraging discussions of controversial topics in the classroom have some issues of its own, however. Firstly, this research suggests that discussing the topic of evolution as a controversy to students whose parents dislike having their beliefs questioned could create
problems for the teacher. Should students go home and tell their parents about these controversial discussions they had in the classroom, such as evolution, parents could try and take action against the school and teacher. An implication of this, in itself, is that administrators will have to deal with unhappy parents and will have to be knowledgeable about what is going on in the classroom to justify the teacher’s actions. Moreover, students who feel uncomfortable with evolution might turn to other staff members, including the Chaplin, who, themselves, have to be knowledgeable and confident on the theory of evolution to support the teacher’s decision to discuss the controversy.

5.2.2 Narrow: Professional identity and practice

These findings have substantial meaning for my professional identity and practice as a future educator. As a Biology teacher, it will be my first and foremost duty to ensure that my classroom is considered an ‘open’ one where students know their opinions will be welcomed. I will also take the time to learn about each of my students and their personal beliefs about evolution. I will try and invite student’s families and communities to discuss the controversy surrounding evolution to hopefully spread awareness on why it should not be a controversy. Moreover, as a colleague, I will encourage other teachers to have conversations about evolution and religion, sharing my research knowledge as well as my personal experiences with them.

This study has changed my perception on the important role a teacher has in the classroom. I, previously, did not acknowledge that teachers can be the encouraging or inhibiting factor in getting students to participate in controversial debates on topics such as evolution. I now believe that a teacher should be open and sensitive to all opinions, regardless if it opposes their own. I also believe the teacher should be a steward for the student, encouraging and helping students develop their individuality. Currently, the purpose of schooling is not centered around
fostering student’s individuality but rather up to the teacher to take this task on independently. Learning from teachers who have successfully done this will not only improve my personal teaching practice but other teachers sharing a similar goal. These implications from the findings have resulted in a number of recommendations, which I list below.

5.3 Recommendations

The recommendations I describe in this section are directed to different parties including teachers, teacher education programs, and administration. First and foremost, I suggest Catholic Biology teachers, while teaching the evolution unit, educate their students on the reasons why a controversy exists. Naturally, that requires teachers having done their research and feeling confident enough to uphold that discussion in their classroom. If this is done correctly, these students will have heard both sides of the argument and will be more reassured in their personal belief. The main benefit of teaching both sides of a controversial topic is the formation of a more understanding and accepting generation. Moreover, Biology teachers should be using strategies that help them in creating an ‘open’ classroom for students. As a colleague, teachers should be working with one another on how best to introduce the topic sensitively.

Secondly, teacher education programs, for example, the Catholicism course required for Catholic teachers, should explicitly teach future educators how to uphold discussions on sensitive issues in the classroom. Furthermore, teacher education programs should develop a way to measure how confident pre service teachers are in their selected teachable.

Lastly, I make a recommendation to administration. Administration should understand the value behind developing a student’s critical thinking skills through the discussion of controversial issues, such as evolution, in the classroom. This understanding will result in a push to have all teachers trained on how to administer these discussions. Furthermore, administration
should be aware when these discussions are taking place in order to anticipate phone calls from parents. Administration should also be knowledgeable about the topic since they might have to justify the teacher’s actions to parents.

5.4 Areas for Further Research

This study presented significant findings on the experiences of Ontario Catholic Biology teachers teaching the evolution curriculum in a Catholic school. While the research obtained from this study generally explored these experiences, I would like to make a call for future research in this area, specifically, research that expands on this study. For example, since a limitation to this study was a small participant size, perhaps alternative findings would have been discovered if the sample size was larger. Moreover, research that looks at the experience of teachers in multiple geographic regions would help draw conclusions on any trends that exist between teacher confidence with the evolutionary controversy, and where they attended their teacher education program or currently teach. The significance of this research would be to pinpoint reasons that might be contributing to teachers shying away from discussing the topic of evolution, or other sensitive issues, in their Biology class. Using these results, future research would be able to make stronger recommendations to the educational community on how teachers can successfully and respectfully teach these issues in their classroom.

5.5 Concluding Comments

The findings from this study are valuable to Catholic Biology educators and administrators who want to encourage students to develop critical thinking skills through the discussion of evolution as a controversy in the classroom. Exploring this controversy in light of religion and science will allow students to better understand the importance of respecting one
another’s different beliefs. I personally believe that this important skill will carry on outside the classroom and contribute to the students becoming intelligent, respectful members of society.
REFERENCES


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*Evolution Education Outreach, 3*, 420-431.


Appendix A: Consent Letter for Interview

My name is Angelica Hessing and I am a student in the Master of Teaching program at the Ontario Institute for Studies in Education at the University of Toronto (OISE/UT). A component of this degree program involves conducting a small-scale qualitative research study. My research will focus on how Ontario Catholic secondary Biology teachers are currently negotiating Catholic doctrine and curricular content on evolution in their teaching. I am interested in interviewing a sample of teachers who have taught Biology, more specifically the Grade 11 Evolution unit, for at least 5 years. I think that your knowledge and experience will provide insights into this topic.

Your participation in this research will involve one approximately 60 minute interview, which will be transcribed and audio-recorded. I would be grateful if you would allow me to interview you at a place and time convenient for you, outside of school time. The contents of this interview will be used for my research project, which will include a final paper, as well as informal presentations to my classmates. I may also present my research findings via conference presentations and/or through publication. You will be assigned a pseudonym to maintain your anonymity and I will not use your name or any other content that might identify you in my written work, oral presentations, or publications. This information will remain confidential. Any information that identifies your school or students will also be excluded. The interview data will be stored on my password-protected computer and the only person who will have access to the research data will be my course instructor. You are free to change your mind about your participation at any time, and to withdraw even after you have consented to participate. You may also choose to decline to answer any specific question during the interview. I will destroy the audio recording after the paper has been presented and/or published, which may take up to a maximum of five years after the data has been collected. There are no known risks to participation, and I will share a copy of the transcript with you shortly after the interview to ensure accuracy.

Please sign this consent form, if you agree to be interviewed. The second copy is for your records. I am very grateful for your participation.

Sincerely,

Angelica Hessing
MT Program Contact:

Dr. Angela Macdonald-Vemic, Assistant Professor – Teaching Stream

Consent Form

I acknowledge that the topic of this interview has been explained to me and that any questions that I have asked have been answered to my satisfaction. I understand that I can withdraw from this research study at any time without penalty.

I have read the letter provided to me by ______________________ (name of researcher) and agree to participate in an interview for the purposes described. I agree to have the interview audio-recorded.

Signature: ________________________________________

Name: (printed) _______________________________________________

Date: ____________________________
Appendix B: Interview Protocol

Thank you for participating in my research study. The aim of this research is to learn how a sample of Catholic, high school Biology teachers are incorporating the Catholic doctrine with the Evolution curriculum content. This interview should take approximately 60 minutes, and is comprised of approximately 18 questions. The interview protocol has been divided into 4 sections, beginning with your background information, followed by questions about your experiences with controversial topics, then your experiences integrating the Catholic graduate expectations and science curriculum, and concluding with questions regarding the integration of the Catholic doctrine and evolution curriculum.

I want to remind you that you can choose not to answer any question, and can remove yourself from participation at any time. Do you have any questions before we begin?

To begin can you state your name for the recording?

Section A – Background Information

1. Where did you receive your teaching education and how long ago?

2. How many years have you been teaching in Ontario?
   a) Have you taught outside of the province before? The country? If so, where?

3. Have you taught in a public school before?
   a. If so, where, how long and which subjects did you teach?
   b. How many years have you taught grade 11 and 12 biology?
   c. Of those years, how many years did you teach the evolution unit?

4. Which grades and subjects do you currently teach?

5. Can you describe your school community (ie. in terms of diversity, socioeconomic status)?
6. Besides your role as a classroom teacher, do you fulfil any other roles in the school (eg. Coach, school club supervisor)?

7. To whatever extent you are comfortable, can you describe your identity as a Catholic and your relationship to the Catholic faith?

Section B – Experience with Controversial topics

8. As a student do you recall discussing controversial topics in the science classroom?
   a) If yes, please describe the issue and context
   b) If no, was it because there were no opportunities or because you, personally, did not take part in them?

9. In your teaching career, have you experienced the discussion of controversial topics (ie. in the classroom, staff room, staff meetings)?
   a) If yes, please describe the issue and context
   b) If no, was it because there were no opportunities or because you, personally, did not take part in them?

10. What is your personal response to the debate/discussion of controversial topics in general in faith-based contexts?
    a. How about in the classroom?

11. As a teacher, have you had a controversial debate/discussion in your classroom?
    a) If yes, what was the topic about? What was the classroom environment like?

Section C – Integration of the Catholic Graduate Expectations and Science Curriculum

12. How does the school or school board support the ability for teachers to incorporate the Catholic graduate expectations within the curriculum (ie. lesson plan guides, staff meetings)?

13. How do you incorporate these expectations in your lessons?
    a. Do you find it more challenging with specific content?

14. Can you describe your level of comfort with the evolution curriculum?
15. As a Catholic, do you generally feel the biology curriculum taught in Catholic schools is appropriate?
   a. In your view, does it contradict the Catholic doctrine? How so/not?

16. Can you walk me through the last time you taught about evolution in your biology class?
   a. **PROMPTS**: lesson design/implementation, student responses, discussion, activities used, successful/not/how they know, what to change next time.
   b. In this lesson, did you share your personal beliefs about evolution with your students?
   c. (If yes) How did you do this? How did the students respond? (If no) Why not?

**Section D – Wrap Up**

17. One of my teachable subjects is Biology and I might have the opportunity to teach grade 11 Biology in a Catholic school, which includes the evolution unit, one day. Do you have any advice that might help a novice teacher, such as myself, on teaching evolution.

18. Do you have any final thoughts?

**Concluding**

Thank you very much for taking the time to be a part of my research study.