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The Stories of Middle School Science Teachers' Teaching Evolution: A Narrative Inquiry

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College of Education

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Abstract

Avoidance of the theory of evolution occurs in science classrooms due to levels of dissonance from challenges that persist in the United States from conflicting worldviews and a lack of support regarding the topic of evolution. The purpose of this qualitative study with a narrative inquiry design was to explore the stories of science teachers teaching evolution in middle schools. This study adopted a qualitative method with a narrative inquiry design. Participants were 10 public middle school science teachers with at least 10 years of science teaching experience in urban, suburban, and rural areas of the Pacific Northwest. The central research question of this study was: What are the stories of science teachers teaching evolution in middle schools? The results disclosed eight major themes: (a) intrinsic motivation from science authors, childhood interests, and family members; (b) microevolution as a common teaching approach to teach evolution; (c) macroevolution as an uncommon teaching approach for teaching evolution; (d) hominins as an uncommon teaching approach for teaching evolution; (e) external challenges of religious conflict among students, colleagues, and parents; (f) internal challenges with colleagues and students; (g) support from administrators and colleagues; and (h) need for support by administrators and colleagues. The findings showed a need for teacher training courses and professional development opportunities. Recommendations for future research are included.

Keywords: acceptance, cognitive theory, evolution, hominins, middle school science, religious sensitivity

Dedication

This dissertation is dedicated to middle school science teachers' teaching evolution.

Acknowledgments

I would like to express gratitude for the many fortunes in my life. The greatest treasure is my daughter, Kelsey Klahn, whose happiness makes me whole. To my mother, a phoenix of epic proportions. To my dearest friend, Jill Mitchell who taught me the art of self-love. And to my life partner, Bryan Mount, whose positivity, reassurance, and endless supply of love made this journey possible.

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Chapter 1: Introduction

Introduction to the Problem

Teachers of biology and life sciences contend with curricular standards that are controversial in nature, namely the framework of biology—the theory of evolution (Nelson et al., 2019). Over 160 years have passed since evidence provided by Charles Darwin's book *On the Origin of Species* was published in 1859. Scientists worldwide accept evolution as a reliable theory of organisms evolving, although cultural objections in the United States exceed national trends (Bertka et al., 2019; Heddy & Nadelson, 2013). Objections are demonstrated in legal battles regarding evolution among anti-evolutionists. However, anti-evolution legislative bills have been suppressed by members of U.S. Congress who cite The Establishment Clause as a separation of church and state (Friedrichsen et al., 2016; Matzke, 2016; Pobiner, 2016). Amidst societal pressures and legal proceedings, science teachers must navigate the controversy while providing sound instruction for students.

Science teachers choose which topics to incorporate into teaching practices. The topic within a unit on evolution connecting humans to the natural world is *human* evolution. Over a quarter (26.8%) of secondary biology teachers reported excluding the origin of humankind (Friedrichsen et al., 2016). This finding correlated with other studies in which researchers suggested that little time is spent on the topic of *human* evolution by secondary science teachers (Berkman & Plutzer, 2015). Numerous studies existed regarding the teaching of evolution among secondary science teachers, while few studies focused on middle school teachers teaching evolution. The purpose of this qualitative study with a narrative inquiry design was to explore the stories of science teachers teaching evolution in middle schools.

Background, Context, History, and Conceptual Framework for the Problem

Background

The controversy surrounding evolution in the U.S. has stemmed from barriers permeating science education and posing a risk to scientific literacy (Glaze, 2018). Scientific literacy in the U.S. was branded *at-risk* following the launch of Sputnik in 1957 by Russian scientists (Hall & Woika, 2018). Meanwhile, the topic of evolution has been avoided by biology teachers in the U.S. (Berkman & Plutzer, 2015; Cofré et al., 2017; Colston & Ivey, 2015). Avoidance of controversial topics implies an incomplete education for students.

A common factor of avoidance with a presence of cognitive dissonance—actions contradictory of knowledge—served as a primary barrier for teachers of evolution (Bland & Morrison, 2015; Glaze, 2015). The cause of dissonance among biology teachers derives from the presence of religiosity, whether it is personal or perceived in others (Ball & Cohen, 1999; Glaze, 2018). The presence of dissonance and the need for awareness to support teachers served as the foundation to explore the stories of teachers of evolution. Stories of 10 middle school science teachers were collected to explore the stories of teaching evolution.

Context

The controversy surrounding evolution dated back most famously to The Scopes Trial of 1925, when a secondary biology teacher was found guilty of teaching the theory of evolution (Hall & Woika, 2018). The 1925 verdict was later overturned but not addressed until 1968 when the United States Supreme Court ruled in *Epperson v. Arkansas*, 393 U.S. 97 (1968) that the teaching of evolution is legal in the U.S. for teachers of science (Goldston & Kyzer, 2009). The past three decades left teachers of evolution faced with a multitude of barriers forcing them to question whether the controversy is worth the risk (Pobiner et al., 2018). While no significant

court cases have been to trial since 2005—as represented in Table 2—strategies to permit religion into public education continues with the use of discreet languages such as *intelligent design* and *academic freedom laws* (Hall & Woika, 2018).

History

Collective stories revealed biology teachers who faced barriers teaching state and national standards regarding evolution without a focus on middle school science teachers. Researchers who conducted studies with biology teachers suggested the presence of internal and external pressures—regarding human evolution in particular—when describing experiences teaching evolution (Bravo & Cofré, 2016; Goldston & Kyzer, 2009). Teachers self-reported a lack of adequate labs and supplemental materials as primary barriers perceived for teaching evolution (Friedrichsen et al., 2016). However, multiple studies by researchers suggested a lack of teacher acceptance, the presence of avoidance and dissonance, along with content deficiency as defining barriers for teachers of evolution (Beggrow & Sbeglia, 2019; Friedrichsen et al., 2016; Glaze, 2018; Lynn et al., 2017). Therefore, a disconnect identified between what science teachers perceived as barriers and those observed in the teaching of evolution. The self-reporting by teachers who reported inadequate teaching materials overshadowed the profound issues of personal belief systems and insufficient training of those in the field of evolutionary sciences.

While multiple skills were essential for teaching science, content knowledge is a basic requirement for best teaching practices. Pedagogical content knowledge is the art of knowing how and what to teach. Barriers compromise curriculum for biology teachers required to teach evolution (Sickel & Friedrichsen, 2013, 2018; Van Dijk, 2009). Science teachers have primarily focused on the content of microevolutionary processes, such as the inheritance of traits within a single population when teaching evolution (Sickel & Friedrichsen, 2013). Macroevolution,

however, represented significant picture relationships between all species with multiple lines of evidence such as DNA sequencing, fossils, and physical characteristics (Goldston & Kyzer, 2009; Nelson et al., 2019). Teachers teaching microevolution and macroevolution were the minority and provided a comprehensive curriculum regarding how organisms are related and have changed over time (Nadelson & Southerland, 2010). Due to ongoing challenges faced by secondary biology teachers, the purpose of this study was to fill the gap regarding middle school science teachers of evolution through the exploration of storytelling.

Conceptual Framework

The construction of a conceptual framework centers on the importance of pedagogical content knowledge and the presence of cognitive dissonance. The act of biology teachers in the U.S. avoiding evolutionary theory stemmed from being underprepared and having personal conflicts concerning evolution (Glaze, 2018; Pobiner et al., 2018). Personal conflicts stemmed from religious beliefs—held or perceived by science teachers—and resulted in the skimming or skipping of standards on evolution (Barnes & Brownell, 2016; Berkman & Plutzer, 2015; Hermann, 2018). Avoidance from personal conflicts and being underprepared are critical barriers for teachers of evolution. The conflict surrounding evolutionary theory was associated with a phenomenon known as cognitive dissonance in which actions contradicted knowledge (Bland & Morrison, 2015). By interviewing science teachers, patterns emerged during transcription and were checked individually for teaching practices and the presence of dissonance.

Opportunities for teachers and students to correct misconceptions and diffuse conflicts surrounding evolution serve to overcome the controversy (Pobiner, 2016). Teachers who addressed the controversy between religion and evolution provided a safe space for diverse ideologies and transformative experiences to overcome the controversy shadowing evolutionary

studies (Bertka et al., 2019; Pobiner, 2016). Long-held misconceptions were vast among teachers in the U.S. (Borgerding et al., 2015; Hall & Woika, 2018). Among those teaching the theory of evolution, some teachers addressed the controversy while others chose avoidance. The practice of offering training in areas where teachers have asked for assistance provided avenues to build content knowledge and confidence to teach controversial standards (Hall & Woika, 2018). Teachers proficient in evolutionary content knowledge and who presented diverse worldviews—free of indoctrination—created space to experience effective teaching practices (Pobiner, 2016). The demand for implementation of pedagogical strategies for science teachers regarding evolution was evident to address common misconceptions and enhance teaching practices.

Effective teaching practices related to overcoming common misconceptions of teaching evolution provided tools for teachers to advance the craft of teaching and build content proficiency. The phrase *just a theory* was a common misuse of the word theory (Orfinger, 2015). A theory has been tested multiple times and was the most widely accepted current explanation among scientists for a given phenomenon (Nelson et al., 2019). Belief systems are personal, abstract in nature, and tend to override facts contradictory in nature (Wood et al., 2012). By researching terms misused during evolution instruction, science teachers prepared to rectify problems before they occur (Gregory, 2009). Researchers in these studies suggested that teachers who sought out common misconceptions enhanced levels of pedagogical content knowledge to overcome obstacles.

The following chart (see Figure 1) represented the perceived obstacles of teaching evolution as identified by secondary biology teachers in the U.S. (Friedrichsen et al., 2016). The last line of the chart titled *Conflict of Personal Acceptance with Evolution* showed that less than 10% of teachers perceived acceptance as a barrier for teaching evolution. However, the U.S. was

rated lower than competing countries in the understanding, accepting, and dissonance levels regarding evolution (Bramschreiber, 2014; Ha et al., 2015). Friedrichsen et al. (2016) conducted a recognition of disparity between the results of this chart and the presence of barriers suggested by researchers in the literature review of Chapter 2.

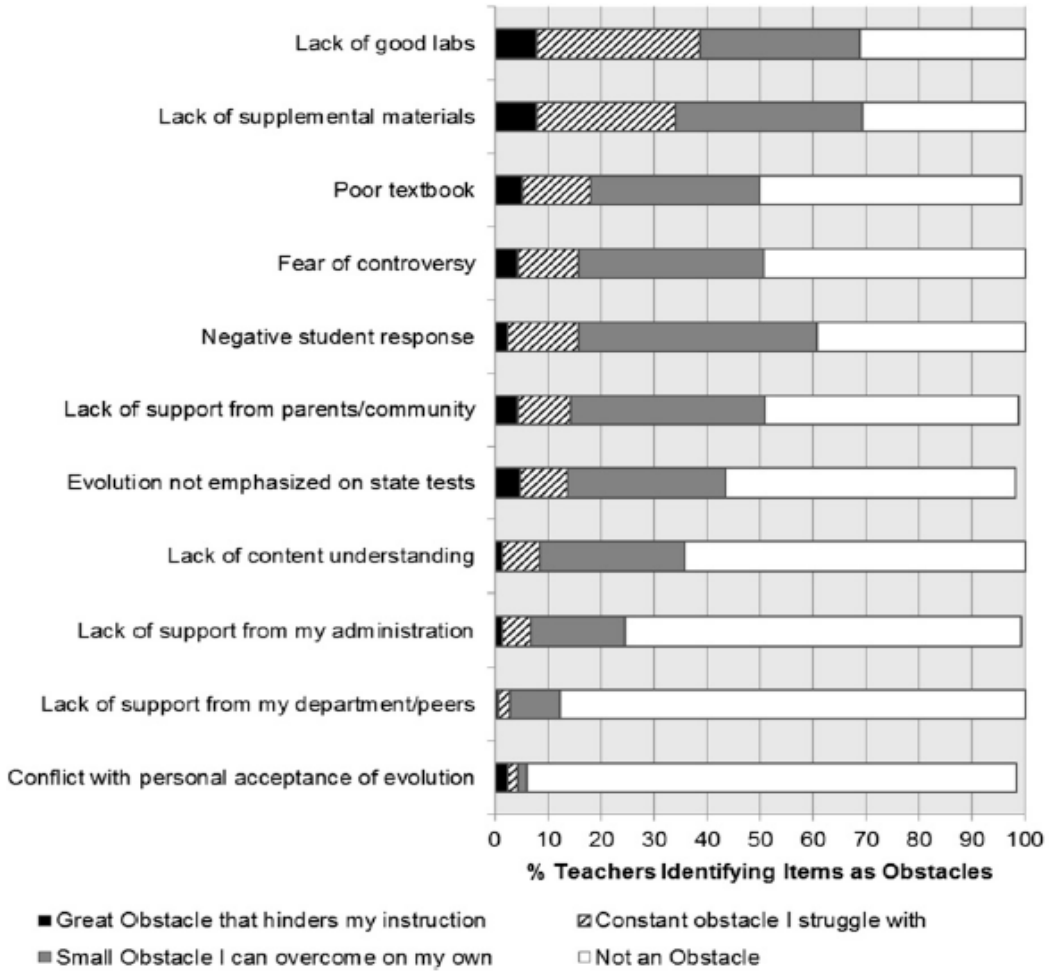

Figure 1. Perceived obstacles to teaching evolution. Reprinted by permission of Dr. Patricia Friedrichsen, Copyright 2016.

Statement of the Problem

The general problem was that secondary biology teachers negated the theory of evolution due to levels of dissonance stemming from a multitude of barriers. Specifically, barriers for science teachers regarding evolution education are:

- Historically controversial topic
- Conflicting worldviews both personally present and perceived in others
- Anti-evolution actions both legally and at the community level
- Teacher preparation regarding pedagogical content knowledge
- Educational resources regarding real-world examples and labs
- Lack of support from administrators and colleagues (Hawley et al., 2019)

Teachers were equipped with state and national standards as a guide for teaching but held flexibility to choose the amount of time spent on each standard (Glaze & Goldston, 2015). Within the branch of evolution education, the specific focus of *human* evolution was obscured or disregarded among science teachers in U.S. classrooms (Friedrichsen et al., 2016). For example, 69.2% of science teachers in a Missouri based study did not teach human evolution or spent less than one 50-minute class period (Friedrichsen et al., 2016). The well-established links concerning human evolution void from science classrooms due to worldviews from personal beliefs and political and administrative pressures coupled with a lack of teacher training and resources (Barnes & Brownell, 2016).

Teachers were provided with a list of state or national standards to serve as a guideline for creating lesson plans to drive teaching methods. However, a trend of avoidance of some standards among science teachers—namely evolution—was suggested due in part to higher levels of religiosity in the U.S. (Heddy & Nadelson, 2013). Each year, more anti-evolution bills

cause a trickle-down effect as the controversy permeates into science classrooms and results in the obscurity or omission of evolution in science education (Friedrichsen et al., 2016). Academic support for teachers of evolution education came with the implementation of the Next Generation Science Standards (NGSS; Vazquez, 2017). Half of all U.S. states held full inclusion of evolution into curricular standards. However, the remaining 50% of U.S. states lacked evident progression in the field of evolution education regarding NGSS (Vazquez, 2017). The inclusion of evolution in NGSS standards suggested an upward trend to support science teachers of evolution.

Science teachers needed appropriate support to teach the historically controversial topic of evolution. Biology teachers were discouraged enough to reduce or omit evolution from biology courses as anti-evolution legislative bills continually surfaced (Finn et al., 2005; Friedrichsen et al., 2016). In addition, researchers suggested a recent and nationwide decline in public perception regarding acceptance and understanding of evolutionary concepts (Miller et al., 2006; Nadelson & Hardy, 2015; Pobiner, 2016). Factors contributing to this problem included the presence of cognitive dissonance, religiosity, and persistence from anti-evolutionists who introduced legislative bills to congress (Barnes & Brownell, 2016; Bland & Morrison, 2015; Friedrichsen et al., 2016).

Avoidance of biological evolution impacts teachers, students, and future leaders of the U.S. who rely on scientists to collaborate within a globally competitive marketplace (Glaze, 2018; Short & Hawley, 2015). For the advancement of scientific literacy, authors of the NGSS incorporated evolution into middle school science standards (Vazquez, 2017). However, science teachers who accepted and understood evolution with conflicting personal worldviews negated the theory of evolution (Bland & Morrison, 2015; Glaze & Goldston, 2015). Researchers

addressed avoidance of evolution among secondary biology teachers, while this study explored stories of middle school science teachers.

Purpose of the Study

The purpose of this qualitative study with a narrative inquiry design was to explore the stories of science teachers teaching evolution in middle schools. The inclusion of evolution into middle school science standards, with the adoption of the NGSS, demanded exploration of the lived experiences of middle school science teachers (Vazquez, 2017). Specifically, the topic of *human* evolution created the highest level of contention, which caused evasion by teachers and scant inclusion in the state curriculum (Glaze, 2018). The field of *human* evolution connected people to the natural world and increased scientific literacy, yet, science teachers avoided this topic due to the ongoing controversy that shadowed the theory of evolution (Pobiner et al., 2018). Human evolution had historically caused the most controversy within the field of evolution and, therefore, was often omitted from teaching practices (Beggrow & Sbeglia, 2019).

Avoidance of human evolution is due to widespread worldviews from personal beliefs and political pressures, coupled with a lack of teacher training and resources (Barnes & Brownell, 2016; Matzke, 2016). Several studies examined professional development needs regarding evolution for secondary biology teachers (Bravo & Cofré, 2016; Friedrichsen et al., 2016; Pobiner et al., 2018), while no studies—to date—focused on middle school science teachers and the stories of teaching evolution. Middle school science teachers teach a course titled *life science*, which is synonymous to secondary courses referred to as *biology*. The purpose of this qualitative study with a narrative inquiry design was to explore the stories of science teachers of evolution in middle school life science courses.

Research Questions

Challenges among secondary biology and college professors who taught the theory of evolution and the following research questions guided the direction of this study. These questions were written to gain an understanding of teaching practices, understand challenges experienced, and to determine the level of professional support provided by administrators and colleagues. The purpose of this qualitative study with a narrative inquiry design was to explore the stories of science teachers teaching evolution in middle schools.

RQ1: What are the stories of science teachers teaching evolution in middle schools?

RQ2: What do the stories of middle school science teachers reveal about the practice of teaching evolution?

RQ3: What challenges, if any, have science teachers experienced or perceived while teaching evolution?

RQ4: What do the stories of science teachers reveal about administrative support regarding evolution education?

RQ5: What do the stories of science teachers reveal about support from colleagues regarding evolution education?

Through the exploration of learning and teaching stories emerged of evolutionary theory among science teachers, contributions led to understand how this controversial topic posits a middle school setting. Questions explore how science teachers have experienced teaching the controversy that has historically and presently pervaded evolution. These questions provided access to the life stories of teachers teaching evolutionary theory, determine teaching approaches of evolution, and discover what these stories reveal about the practice of evolution education in public middle school settings. Data were used to reveal how educational leaders and school

administrators could benefit middle school science teachers in the quest to enhance evolution education, thereby improving scientific literacy.

Teachers were considered *professionals in isolation* who were in the business of performance and rarely took time to pontificate on academic practices (Clandinin, 2006). These questions provided a framework to guide the development of open-ended, semistructured questions. Semistructured questions allowed participants to describe how they experienced the teaching of evolution in their own words. Interview questioning followed a semistructured format to keep participants within the realm of the study while allowing a natural flow of storyline to develop throughout the process (Kim, 2016).

Rationale, Relevance, and Significance of the Study

Rationale

The link between biological evolution and scientific literacy beckoned the stories of middle school science teachers of the theory be explored and retold. Through the interview process with middle school science teachers responsible for teaching evolution, deep meanings were revealed regarding the practice of evolution education in middle schools the Pacific Northwest. This data offered evidence of how teachers have experienced the teaching and learning of evolution by determining how the topic has impacted personal and professional experiences. Analysis of data disclosed how evolution compared to other standards and provided science teachers and leaders in education key points for supporting teachers of evolution.

Relevance

The scope of this research encompassed middle school life science teachers within U.S. public schools who already included evolution in the science curriculum. Middle school life science teachers held extenuating pressures to teach controversial topics to an inimitable

audience of middle school students (Shymansky et al., 1993). The inspiration to listen and transcribe stories of teachers of evolution came from a transformative journey. From the pivotal moment of first learning about extinct human ancestors to the vast experiences of teaching evolution for 17 years in middle and secondary science courses, I returned to learning from stories of fellow teachers.

Significance

The significance of this study are the multiple stories illuminated through 10 one-on-one interviews with a narrative design. These interviews served to explore events chronologically that shaped the educational learning and practice of the theory of evolution. Semistructured interview questions brought flexibility to the interviewer and interviewees to determine how the theory of evolution was situated in a middle school classroom in various regions of one U.S. state. My experience teaching evolution brought a unique perspective as I recorded and retold stories from middle school science teachers. Stories gained from this research serve to benefit middle school science teachers and those interested in supporting the teaching of evolution such as administrators and supporting staff members.

Definition of Terms

The following terms and phrases explicitly define the scientific verbiage of this study. Words and phrases are listed in alphabetical order and include biology terms to clarify meanings within the study contextually. The chosen list is critical towards the goal of understanding the stories of teachers of evolution.

Bipedalism: This term is defined as the rare act of mammals walking primarily upright on two legs (Harcourt-Smith, 2010).

Cognitive dissonance theory: This phrase is defined as a theory proposed to explain the phenomenon of acting against what is known to be factual, regardless of the consequences (Festinger, 1957).

Hominins: Formerly known as hominids, the term is defined includes *Homo sapiens* and the bipedal, extinct ancestors and exclude the great apes (Pontzer, 2012).

Pedagogical content knowledge: This phrase is defined as the content knowledge of a teacher, along with how the material translates to students (Corrigan et al., 2011).

Scientific literacy: This phrase is defined as the knowledge of basic scientific concepts and processes required for problem-solving (NSTA, 2003).

*Theory***:** This term is defined as a process that has been tested multiple times by the scientific community and will not change unless disproven or a more valid theory replaces the current one (Nelson et al., 2019).

Assumptions, Delimitations, and Limitations

Assumptions

Assumptions accompany the nature of qualitative research. It is the assumption that participants understand the influence storytelling has on self-reflection and educational research regarding evolution. The assumption held that participants knew the value of their contribution with the knowledge that their stories were powerful, unique, and impactful. A final assumption is that participants remained forthright and honest in responses given to build a comprehensive understanding of stories of teaching evolution.

Delimitations

A delimitation of this study is the sparse number of participants who are not representative of every middle school science teacher in the U.S. Ten teachers were chosen to

give ample time to gain detailed accounts of the events experienced by teachers of evolution. The use of a low sample size allows a researcher to go beyond the surface layer of to explore deeper meanings of experiences as described by participants (Polkinghorne, 2007). Teachers in this study were public middle school science teachers who had taught at least 10 years.

Having no prior relationship with participants served as another limitation to gain enough trust from participants to reveal detailed aspects of the stories told. Teachers were acquired with the method of snowballing in which one teacher learns about the study and then tells another who fell within the criteria set for the study. The criterion was teachers who were retired or currently teaching for at least 10 years in middle grades education who had ample experience in evolution education. By recognizing limitations and carefully considering delimitations of the choice of 10 participants, more attention allows in-depth and accurate depictions of stories in evolution education.

Limitations

The limitations of this qualitative research were size, authenticity, and personal experience. The small sample size of 10 participants prevents generalization to a larger population. A small sample size was chosen to gain detailed stories from participants. An additional limitation is truthfulness. It is unknown whether participants were honest while disclosing stories during the research process. Finally, the personal experience of being a teacher of evolution created bias to be identified and acknowledged. In addition, the personal experience of being a novice research added to the limitations of this study.

Chapter 1 Summary

Storied evidence uses a conceptual framework of dissonance and historical references of biology teachers and college professors. The conceptual framework section includes the

significance of pedagogical content knowledge concerning controversial topics, and the common theme of the *nature of science* as a precursor to understanding and accepting evolution. The historical background of the evolution section includes the practice of indoctrination in U.S. public schools, recent legal proceedings and the effect held on educators, and the recent inclusion of Academic Freedom Bills. The specific focus of human evolution is to draw attention to the branch of biology most avoided. Further, this section describes how teachers are standards-driven to prepare students for statewide assessments of which results evaluate teacher effectiveness. There is a practice of avoidance by teachers of evolution. This study will fill the gap regarding stories of middle school science teachers of evolution.

Chapter 2: Literature Review

Introduction to the Literature Review

The Opening

In my 17 years of teaching middle school science and biology, the topic of evolution remained most challenging to understand and teach effectively. This review of the literature examines studies concerning the historical background of evolution education to included barriers experienced by teachers of evolution. While biology teachers have long been responsible for teaching evolutionary theory, the recent onset of the standard has been implemented for middle school science teachers who have incorporated the NGSS into their teaching practices.

Throughout the teaching of middle school science and biology, the topic of evolution held the most contention. Evolution remained most challenging to understand and teach effectively when compared to other science standards. This review of the literature examines studies concerning the historical background of evolution education to included barriers experienced by teachers of evolution. While biology teachers have long been responsible for teaching evolutionary theory, the recent onset of the standard now applies to middle school science teachers. Evolution became part of the NGSS in 2013. This review of the literature will include the balance of the NGSS in U.S. classrooms and the four major topics including scientific literacy, pedagogical content knowledge, cognitive dissonance theory, and the theory of evolution.

Curricular decisions made by science teachers govern scientific literacy. Administrators and teachers face significant challenges to enhance scientific literacy in the U.S. to be competitive in a global economy (Moore et al., 2015). In 2012, 69% of U.S. students who took the ACTs college readiness test failed to meet science benchmarks (ACT, 2012). To meet this

demand, representatives of state-led efforts acquired members of the National Research Council, the National Science Teachers Association, and the American Association for the Advancement of Science to collaboratively write new science standards referred to as the NGSS in 2013. Since then, less than half of U.S. states have implemented NGSS standards, which include standards specific to the theory of evolution. However, the remaining states have not implemented NGSS into the science curriculum as of 2017 (Vazquez, 2017). State and national standards influence just part of the curricular decisions made by science teachers.

Science teachers in the U.S. have focused on highly tested standards due to high stakes testing procedures. Avoidance on the topic of evolution stemmed from religious beliefs and a lack of training (Cofré et al., 2017). The National Science Teachers Association position statement emphasized that the absence of evolution in the science curriculum reduces scientific literacy (NSTA, 2003). Several studies conducted with biology teachers and the stories of teaching evolution, yet few studies exist that focused on the stories of middle school science teachers (Friedrichsen et al., 2016; Goldston & Kyzer, 2009; Sickel & Friedrichsen, 2018). While great strides are in place to legally support evolution in science classrooms, challenges remain for teachers teaching evolutionary theory (Glaze & Goldston, 2015; Pobiner, 2016). The use of personal beliefs to moderate curriculum leave students with an incomplete education.

Science teachers who are well-trained and have support systems in place to teach curriculum provided in national and state standards advance scientific literacy, according to the NSTA (2003). The NSTA position statement on the teaching of evolution was concluded by members to state that without evolution, students may have compromised levels of scientific literacy. This qualitative study is a narrative inquiry design used to explore the stories of science teachers teaching evolution in middle school life science courses.

The Study Topic

The topic of this research is to understand how teachers of middle school science have experienced teaching evolution. By gaining a multitude of details from teachers of evolution, stories are told and retold about the state of evolution education in a middle school setting. A review of the literature narrowed the broad scope of teaching evolution, specifically to middle school science teachers concluded from the extent of studies available regarding biology teachers.

The Context

According to several researchers, further research regarding evolution education requires studies based on the extent to which science teachers understand and incorporate evolution (Borgerding & Deniz, 2018; Cofré et al., 2017; Rice et al., 2015). To achieve compliance with state and national curricular standards, the need for knowledge improvement among science teachers is evident (Cofré et al., 2017). The research consistently supported the application of extensive training to support teachers of evolution education.

The following databases offered access to gain scholarly research as a literature search strategy: Pro-Quest, Eric, Wiley, Taylor and Francis Online, Science Direct, Springer Link, and One-Search. Key terms and phrases included: *biological evolution; human evolution; pedagogical content knowledge; cognitive dissonance theory; professional development, sociocultural theory,* and *evolution education* as the overlapping claims explored in studies over the past three decades. Table 1 included four major topics of studies reviewed regarding evolution education since 1986, which included scientific literacy, pedagogical content knowledge, cognitive dissonance theory, and the theory of evolution. Initially, the search regarding the relationship between evolution education and scientific literacy yielded 37 peer-

reviewed articles, two dissertations, and one online resource. The next search dealt with the level of pedagogical content knowledge regarding evolution education to result in 23 peer-reviewed articles and one dissertation. Seminal works served as the foundation for this study, which led to the theory of cognitive dissonance. Two articles and two dissertations were accessed. Finally, the basis of this research was the theory of evolution with 25 peer-reviewed articles, three dissertations, and one on-line source recorded in Table 1. In total, 95 peer-reviewed articles, eight dissertations/theses, and three online sources were referenced.

Table 1

Summary of Studies by Topics

Topic of Examination	Peer-Reviewed Articles	Dissertation & Thesis	Online Sources
1. Scientific Literacy	37	2	1
2. Pedagogical Content Knowledge	23	1	0
3. Cognitive Dissonance Theory	10	2	0
4. Theory of Evolution	25	3	2
Totals	95	8	3

The Significance

The potential impact of these stories retold gave access to certain events that could enhance the field of middle school science education. Stories garnered shed light on stories of teaching evolution and discovered support measures that either aided or hindered the teaching process and revealed teaching practices. Furthermore, stories disclosed the challenges of those teaching evolution in a middle school setting. Stories told and retold benefit those interested in

evolution education, including students, science teachers, parents, administrators, and researchers of evolution education.

The Problem Statement

The theory of evolution poses no controversy among the scientific community, although the topic continues to cause contention in the field of education, particularly in the United States (Bertka et al., 2019). The disconnect between an acceptance and understanding of evolutionary theory among the scientific community compared to evolution education in the U.S. prompted this study. High school biology teachers reported barriers to teaching the theory of evolution resulting in avoidance of the topic (Friedrichsen et al., 2016). In general, the problem centers on biology teachers, who have negated the theory of evolution due to levels of dissonance stemming from a multitude of barriers (Bland & Morrison, 2015; Glaze, 2015). Specifically, these barriers include cultural barriers such as religious beliefs (Pobiner et al., 2018), lack of teacher preparation (Pobiner & Patterson, 2017), antievolution policies (Hall et al., 2018), and Academic Freedom Laws (Glaze & Goldston, 2015).

The presence of dissonance among science teachers who accept and understand evolution education held conflicting personal worldviews (Bland & Morrison, 2015; Glaze & Goldston, 2015). Avoiding controversial topics allows one to maintain control by reducing the likelihood of adverse effects. A common factor of avoidance associates with cognitive dissonance—actions contradictory of knowledge—serving as a primary barrier for teachers of evolution (Bland & Morrison, 2015). The cause of dissonance among science teachers has been linked further to the presence of religiosity, whether it is personal or perceived in others (Glaze, 2018). The presence of religiosity that has led to dissonance and avoidance of state and national curricular standards serves as the foundation of this study.

Specifically, within evolution education, the branch of *human* evolution is obscure or absent among science teachers in U.S. classrooms (Finn et al., 2005; Friedrichsen et al., 2016). Teachers are equipped with state and national standards as a guide for teaching but have the flexibility to choose the amount of time dedicated to each standard (Glaze & Goldston, 2015). It is the discretion of each teacher to create a timeline or pacing guide for each curricular standard. For example, 69.2% of secondary biology teachers in Missouri did not teach *human* evolution or spent less than one 50-minute class period (Friedrichsen et al., 2016). The well-established links concerning human evolution go without representation due to widespread worldviews from religious beliefs and political and administrative pressures coupled with a lack of teacher training and resources (Barnes & Brownell, 2016; Matzke, 2016). A multitude of barriers for science teachers resulted in reduction or omission of the topic of human evolution.

Researchers revealed barriers among biology teachers who advocated for support in evolution education (Bland & Morrison, 2015; Bramschreiber, 2014). The widespread disdain among anti-evolutionists has significantly impacted those responsible for the teaching of evolution in science classrooms (Berkman & Plutzer, 2011). The most considerable influence is on science teachers who have embraced evolution education but are sensitive to attitudes regarding controversial issues from administrators and community members (Lynn et al., 2017). Teachers accept and understand the theory of evolution, although the presence of internal and external factors impinge on teaching methods and approaches.

Political action from anti-evolutionists introducing bills to congress place political pressures on science teachers (Friedrichsen et al., 2016). Avoidance of evolution from biology teachers in the U.S. has stemmed from barriers that permeate the field of biological evolution, posing a risk to scientific literacy. Scientific literacy in the U.S. was branded 'at-risk' following

the launch of Sputnik in 1957 by Russian scientists (Hall & Woika, 2018). Meanwhile, controversial topics—namely, evolution education—have been avoided by science teachers in the U.S. (Berkman & Plutzer, 2015; Colston & Ivey, 2015). Avoidance of evolution from science teacher sensitivity to administrators and community members who shy away from controversial issues (Lynn et al., 2017).

Despite legal protections for evolution education, the states of Tennessee and Louisiana adopted *academic freedom* bills that permit teachers to offer alternatives to teaching evolution (Hall & Woika, 2018; Pobiner, 2016). Pobiner (2016) identified specific language in the bills written and passed by the states of Louisiana in 2008 and Tennessee in 2012. The language of academic freedom bills includes permission for antievolutionists to disregard evolution. Such bills present nonscientific ideas that leave students confused about the definition of a theory (Hall & Woika, 2018). The level of controversy is varying among different topics used to teach the theory of evolution.

The Organization

Chapter 2 includes an opening, study topic, context, significance, a problem statement, and a section on the organization. The *Conceptual Framework* includes pedagogical content knowledge, cognitive dissonance theory, and the theory of evolution to gain perspective for persistent dissonance clung to evolution education. Methods provide a framework to illuminate how teachers perceive evolution education. The *Historical Background of Evolution Education* culminates in legal matters concerned with teaching evolution, followed by *Barriers of Teaching Evolution* to report current perceptions. The section on *Methodological Issues* and *Synthesis of Research* will indicate the quality and quantity of research of evolution education. By reviewing

the literature of recent evolution education in the U.S., these studies summarize to locate a gap in the literature offering implications for this research.

Conceptual Framework

The following conceptual framework includes the impact of evolution education on the exploration of pedagogical content knowledge—concerning evolution—among science teachers. These factors provide evidence supported by the presence of cognitive dissonance theory (Festinger, 1957). The basis of this study—theory of evolution—has been paralleled to the theory of gravity for the accuracy of claims among scientists worldwide (Nelson, 2007). Theoretical concepts exemplify the use of a narrative inquiry approach to organizing human experiences (Schaefer & Clandinin, 2019). These early works provide a critical lens to collect data on evolution education and the present state of evolution education as perceived by science educators.

Pedagogical Content Knowledge

Shulman (1987) presented pedagogical content knowledge to observe and measure science proficiency demonstrated by teachers. Pedagogical content knowledge is the consideration of a teacher's experience of content and the knowledge of how to teach (Brown et al., 2013). Professional understandings and beliefs fall within a study of pedagogical content knowledge to hold unique and diverse levels of comprehension regarding evolution education (Bravo & Cofré, 2016). Teachers exposed to numerous sessions of professional development showed substantial gains in science content knowledge (Bayer & Luberda, 2016). Therefore, teachers who participate in ongoing professional development for science education are working to enhance their pedagogical content knowledge.

Cognitive Dissonance Theory

Nationwide acceptance of the theory of evolution among the U.S. population has declined from spiritual commitment and political orientation (Nadelson & Hardy, 2015). Cognitive dissonance, however, has been suggested as the primary barrier for science teachers who have not incorporated evolution into the framework of life sciences (Bland & Morrison, 2015). Dissonance causes the avoidance of the theory of evolution among science teachers. The concept of cognitive dissonance is the internal conflict between what one understands to be accurate being inconsistent with actions carried out (Glaze, 2018). Studies to date are representative of biology teachers and students, along with higher education biology professors. Few research studies are available to view evolution through the lens of cognitive dissonance to explore the stories of middle school science teachers.

Within science education, conflicts between scientific and religious worldviews create a platform for dissonance to reveal certain biases (Pavuk, 2016; Seoh et al., 2016). Implicit biases are prejudices held by someone unaware of behaviors of partiality (Banerji, 2005). Some science teachers have unknowingly spent more time on one standard and less time on another exhibiting implicit bias behaviors. For Gregory (2009), the presence of biases regarding evolutionary theory began during childhood and has served as a precursor to the difficulty of understanding this complex theory among most participants. Through acknowledgment of such biases and by utilizing a sensitivity towards diverse worldviews, teachers can work to overcome such dissonance.

The Theory of Evolution

Evolutionary theory—espoused by Charles Darwin—describes the process in which populations of organisms change over time (Clarke-Midura et al., 2018; Mead et al., 2017).

However, the phrase *change over time* can be misleading. Organisms do not change as individuals, nor do individuals change within a lifetime (Flammer, 2006). Instead, *natural selection* is the process in which favorable traits within a population allow a population to thrive in specific environments, reproduce, and pass traits to offspring (Friedrichsen et al., 2016). The process of natural selection—used to explain evolution—is poorly understood by the majority of K–12 and postsecondary students alike (Gregory, 2009). The theory of evolution is the subject of this study to gain insight through the telling of a story to be told and retold. Once there is a proficiency in basic scientific concepts (Sickel & Friedrichsen, 2018), the theory of evolution is taught through multiple avenues of evidence to describe the connectivity of life on earth (Vazquez & Friedhoff, 2017). The researcher used narrative inquiry to examine stories from teachers of evolutionary sciences.

A growing concern for scientific literacy among stakeholders in the U.S. has attributed to reduced levels of understanding of evolutionary sciences from teachers nationwide (Ha et al., 2015). In this study, 28 teachers K–12 took quantitative assessments with pre and post-test data, which determined that teachers demonstrated no more than a modest skill to convey concepts of evolutionary change. The results of this study align with similar studies, which reported a lack of understanding and acceptance from science teachers as a direct factor in the teaching of evolution (Lynn et al., 2017; Pobiner et al., 2018). A focus turns to analyze science expertise among science educators to understand teaching content.

While a lack of training is evident within evolution education, research exists on avoidance of evolution. Glaze (2018) interviewed 10 preservice secondary biology teachers with a narrative inquiry design to determine what influences the acceptance of the evolutionary theory. The psychological theory explained why the behaviors of avoidance occurred. Teachers

thought processes were charted and revealed that even when an understanding of evolutionary concepts is evident, a presence of cognitive dissonance resulted in teachers skimming or skipping over evolution to avoid controversy (Glaze, 2018). Thus, even though teachers knew evolutionary concepts to be factual and part of the state-mandated curriculum, they choose to avoid the topic to circumvent conflict with students, parents, colleagues, and administrators.

Compromised pedagogical content knowledge and a presence of cognitive dissonance led to the negation of evolution instruction (Mead et al., 2017). Effective pedagogical practices regarding scientific literacy unveil in a recent study of science teachers who displayed empathy for theistic beliefs versus those who avoid the controversy. The awareness of personal dissonance prompted researchers to provide activities sensitive to religious beliefs during the teaching of evolution (Glaze, 2018; Pobiner et al., 2018). A study by Pobiner et al. (2018) suggested that religious-sensitivity lessons alleviated stress and resulted in an increased aptitude among participants regarding the theory of evolution. In this study, theism is not offered as an alternative to evolution—as proposed by those in opposition to evolutionary concepts—instead, theistic ideas are defined and acknowledged as a personal system of beliefs. Within this study, biology students (n = 340) from eight U.S. states experienced cultural and religious sensitivity activities to learn about evolution. A brief discussion of personal beliefs is pivotal in fostering student trust and created a safe space for ideas to flourish. Discussions about acceptance of various cultures and religions foster higher-level critical thinking skills allowing transformational processes to emerge as an exemplary teaching practice (Nelson, 2007).

The focus of evolution education in professional development has addressed common misconceptions prevalent among biology teachers (Hall & Woika, 2018; Wilbur & Withers, 2015). Correcting common misconceptions among science teachers transcend into evolution

education, thus improving scientific literacy (Hermann, 2018). As science teachers continue to request professional development for evolution education (Romine et al., 2014), more research is needed to explore further science teacher's pedagogical content knowledge regarding evolutionary sciences (Sickel & Friedrichsen, 2013).

Review of Research Literature and Methodological Literature

The emerging theme of addressing the controversy of religiosity alongside evolution has overshadowed the customary practice of teacher avoidance (Glaze, 2018; Pobiner, 2016). In a recent study, Pobiner (2016) viewed specific language in anti-evolution bills to create engaging teaching materials with a sensitivity to various worldviews. This research offered an alternative to the practice of avoidance of personal or perceived worldviews such as religious conflict. Through investigation, this study used survey instruments to promote the use of religious sensitivity to teach human evolution as a primary teaching tool concerning evolution education that resulted in effective results (Pobiner, 2016). Addressing the controversy without steering students in the direction of religiosity or negating the theory of evolution held a positive outcome in evolution education. This review of research literature includes religion, political pressures, legalities, indoctrination, environmental challenges, standards-driven curriculum, several barriers, and ends with recommendations regarding evolution education.

Evolution Education and Religion

Many teachers avoid the controversy by not discussing the ongoing conflict of religion versus the theory of evolution or have avoided the section on evolution altogether (Borgerding et al., 2015; Goldston & Kyzer, 2009; Larkin & Perry-Ryder, 2015). Researchers Glaze (2018) and Pobiner et al. (2018) focused on religious sensitivity among teachers of evolution education. While Glaze (2018) found the lens of dissonance to be unwavering in the southeastern portion of

the U.S., Pobiner et al. (2018) chose a broader sample of participants across eight states. The results from the Pobiner et al. (2018) study implied the use of human case studies in evolution education held a positive effect when compared to other evolution education teaching practices. Analyzing these results prompted a secondary gap within the literature to focus on human evolution education among middle school life science teachers. Religion is a worldview enacted to reach the diversity of worldviews among all participants (Glaze, 2018; Pobiner et al., 2018). A narrative inquiry is needed to bring awareness to the current state of the teaching of human evolution among middle school science teachers.

Teachers who orchestrate thoughtful debate over the controversy of evolutionary theory are effective in their practice. Such debates follow legal and ethical procedures provided they follow state and national guidelines of educational standards (Sickel & Friedrichsen, 2013). Glaze (2018) provided research that pointed to religion as the number one factor in acceptance or rejection of the evolutionary theory. The factor of religiosity—referred to as worldviews—is suggested as the reason for cognitive dissonance (Bland & Morrison, 2015). Pobiner et al. (2018) devised a teaching strategy to engage conversations about personal worldviews that supported evolution education as beneficial for scientific literacy. Religious sensitivity approaches lead to effective teaching practices of the concepts of evolution (Glaze, 2018; Pobiner, 2016). Addressing worldviews created a dynamic shift to discuss controversial matters openly and honestly and worked to overcome dissonance.

Levels of dissonance have been inconsistent regarding evolution. Due to dissonance (Bland & Morrison, 2015), forward progression of the teaching evolution has resulted in ebbs and flows of acceptance rates among U.S. citizens with a five percent decline in the past 20 years (Miller et al., 2006; Pobiner, 2016). In a study of 34 industrialized countries, participants of the

U.S. scored 33rd place as the least accepting of evolution (Borgerding & Deniz, 2018; Miller et al., 2006). Additionally, a two-group structural equation model was applied to examine multiple variables to include attitudes towards science and religion as well as political preference. This study analyzed the view of public acceptance of the general population and did not focus on the controversy of teaching evolution from the perspective of educators (Miller et al., 2006). An awareness of dissonance has revealed connections between what is understood and responses from societal pressures.

Political Pressures and Trust in Scientists

Along with religious affiliation, levels of trust in the scientific community and political interest groups have influenced the teaching of evolution (Hall & Woika, 2018; Nadelson & Hardy, 2015). The exploration of how and why a mistrust of science has developed is central to closing gaps between religious beliefs and scientific principles (Pobiner, 2016). According to this study, U.S. citizens believe that scientists have substituted reliable data with skewed data for financial gain, citing corporate drug companies as a representative example. Teachers are left to contend with teaching data that is controversial among the general population.

The lack of trust in scientific data along with political interest groups have played active roles in evolution education, precisely avoidance of human origins. The federal court case of *Kitzmiller et al. v. Dover*, 400 F. Supp. 2d 707 (2005) stemmed from the teaching of human evolution, is one of many cases that reopened the decision making the topic even more challenging to teach (Nelson, 2007). These connections promoted the advancement of scientific literacy (Nelson, 2007; Pobiner et al., 2018). Inevitably, studies revealed that teachers prepared to welcome discussions of the origins of humanity, which have modeled a rich understanding of the human connection to the living world, therefore enhancing evolution education.

Legal Proceedings

Worldwide, scientific communities have concluded that evolution education is central to understanding sciences, while anti-evolution bills have continually surfaced (Pobiner et al., 2018). The backlash of teaching evolution dates back most famously to the Scopes trial of 1925 in which the teaching of *human* evolution was heavily debated (Pavuk, 2016). However, contemporary anti-evolutionist efforts have continually applied various measures to reduce or disregard the teaching of all aspects of evolution (Borgerding et al., 2015; Watts et al., 2016).

Legal cases regarding evolution education have highlighted the sensitivity of the topic and given science teachers legal parameters to teach all state standards (Borgerding et al., 2015). A summary of federal legal court cases on evolution education lists cases within the U.S. (see Table 2). These cases included five teachers and five parents who sued three states and seven school districts either in support or opposition to religious advocacy in science education. Justices ruled all 10 cases to support the teaching of evolution and cited the indoctrination of creationism into the science curriculum as unconstitutional. The First Amendment Establishment Clause states: “Congress shall make no law respecting an establishment of religion or prohibiting the free exercise thereof. Two clauses of the First Amendment concern the relationship of government to religion: The Establishment Clause and the Free Exercise Clause” (Hall & Woika, 2018, p. 236). The courts have further labeled any alternatives to evolution as nonscientific and unconstitutional (Bradshaw et al., 2018; Pobiner, 2016).

In several school districts, disclaimer stickers posted on the cover of biology and life science textbooks prompted legal action (Hall & Woika, 2018; Hermann, 2018). Disclaimer stickers prompt readers to question the validity of the information within textbooks. Lawmakers ruled the placement of the stickers unconstitutional and ordered they be removed, citing the

participants as actively promoting creationism (Hall & Woika, 2018). Instances in which science has been discredited have been overturned in court cases (see Table 2). Findings from these cases make known that lawmakers unify the validity of evolution education (Hall & Woika, 2018).

The absence of significant court cases over the past 15 years is evidence that evolution education has begun to gain traction regarding the legal safety of teachers responsible for teaching the theory of evolution. There is an upward trend suggesting support for evolution education. According to Vazquez and Friedhoff (2017), this trend subsided with laws that counteracted the forward momentum of evolution education. Legislation stated that any resident could legally challenge educational curriculum, regardless of their educational background or understanding of the curriculum put into question (Vazquez & Freidhoff, 2017).

The following table includes 10 legal court cases from 1968–2005, which concluded that teaching creationism in the U.S. is unconstitutional based on the Establishment Clause. The case of *Edwards v. Aguillard*, 482 U.S. 578 (1987) made a significant case against teaching religion as fact. In this case, legislators in Louisiana determined that if creationism is taught as an alternative to evolution, it would be unconstitutional. The 10 cases were heard in the states of Illinois, Minnesota, Georgia, and Pennsylvania. Two distinct cases were represented in Arkansas, California, and Louisiana. Fifty percent of the cases were held in southern states of the U.S. and 50% were in northern states. Seventy percent of legal cases address the school board, and 30% addressed the state of the schools' location. Forty percent of cases filed by parents sued the school, and 10% were parents who sued the state. Thirty percent of cases were filed by teachers who sued the school and 20% against the state. All 10 cases ruled in favor of teaching evolution and determined the teaching of creationism in U.S. science classrooms as unconstitutional.

Table 2

Summary of Evolution Education Legal Court Cases 1968–2005

Year	Case	Ruling
1968	Teacher v. State- pro evolution: *Epperson v. Arkansas*	Teacher vs. State pro evolution: Arkansas' anti-evolution legislation was deemed unconstitutional
1981	Parent v. State- against evolution: *Segraves v. the State of California*	California's anti-dogmatism policy did not infringe upon the First Amendment rights.
1982	Parent v. School- against creationism: *McLean v. Arkansas Board of Education*	Arkansas laws requiring the teaching of creationism ruled unconstitutional.
1987	Teacher v. State- against creationism: *Edwards v. Aguillard*	Louisiana legislation forced creationism taught in conjunction with evolution ruled as unconstitutional
1990	Teacher v. School- pro creationism: *Webster v. New Lenox School District*	Illinois courts ruled religious advocacy is unconstitutional
1994	Teacher v. School- pro creationism: *Peloza v. Capistrano School District*	California courts ruled that religious advocacy is unconstitutional
1997	Parent v. School evolution statement: *Freiler v. Tangipahoa Parish Board of Education*	Louisiana courts ruled that the school board endorsed religious viewpoints deemed unconstitutional
2000	Teacher v. School- against evolution: *Rodney LeVake v. Independent School District 656*	Minnesota courts ruled religious advocacy is a violation of the Establishment Clause and deemed unconstitutional
2005	Parent v. School- evolution statement: *Selman et al. v. Cobb County School District*	Georgia's anti-evolution disclaimer in textbooks ruled unconstitutional
2005	Parent v. School- against creationism: *Kitzmiller et al. v. Dover*	Pennsylvania school board members required teachers to use the phrase *intelligent design* ruled unconstitutional

Indoctrination

As discussed earlier in the literature review, there is a distinct difference between a theory and a belief, both containing limitations. A survey of 395 postsecondary biology students combined with interviews from 44 collegiate students was analyzed utilizing a mixed-methods study to determine levels of acceptance of college biology students (Borgerding et al., 2017). Researchers from this study compared three sub-groups of students within three different science courses: Evolution, Biodiversity, and Life on Planet Earth. They concluded that students in the first group were less likely to accept the uncertainty of science and more likely to view science as the highest authority of knowledge (Borgerding et al., 2017). The goal of science educators should not be indoctrination of any kind—science or religion—but to share knowledge and limitations and to pique curiosity to learn more about the natural world (Bertka et al., 2019; Borgerding et al., 2017). A suggestion of teaching science with levels of uncertainty led students to conclude inconsistent with valid scientific concepts such as evolution.

Environmental Challenges

Environmental contributory factors include consumables (labs used one time), non-consumables (textbooks and technology), and county pacing guides that direct the teacher based on state and national standards to teach evolution. In the state of Missouri, 38.8% of biology teachers (n = 276) self-reported a shortage of labs and additional equipment to teach evolution and cited the need for professional development in the field of evolution (Friedrichsen et al., 2016). Studies of publishers of textbook companies who have skimmed or excluded the topic of evolution along with evading common misconceptions exist (Short & Hawley, 2015). These external factors support the claim that teaching evolution comes with substantial challenges for science teachers.

Standards Driven Curriculum

The focus on the standards-driven curriculum indicates the necessity of quality standards to enhance scientific literacy. However, specific topics within state and national standards are given priority in preparation for state exams (Borgerding et al., 2015; Friedrichsen et al., 2016). A multiple case study was conducted with three preservice science teachers to explore what influences the approach to teach evolutionary theory. Participants in this study reported that the state exam was the driving force behind evolution education (Borgerding et al., 2015). State and national standards drive the pacing guide created for teachers to circumnavigate. In a study by Friedrichsen et al. (2016), 86.2% of participants revealed less emphasis on evolution on state tests. The teaching of science is best delivered by teachers who place value on all standards, including standards most challenging to teach (Vazquez, 2017). Public educators have legal and ethical obligations to teach all standards. However, there is flexibility to prioritize, emphasize, and reduce implementation of standards.

Policy Guidelines

State and national standards serve as policy guidelines that create a framework for teachers while providing legal protection to deliver quality science education (Vazquez, 2017). For Vazquez (2017), the disparity among evolution in state standards was made evident during a comparison study. A nationwide study examined the inclusion of evolutionary concepts in Grades 6–8. Assessment of life science standards offered a grading system of A–F. Following a rubric, the researcher awarded U.S. states as follows: 23 As, one B, six Cs, five Ds, and 15 Fs. Results showed a positive trend in the presence of evolution in middle school state science standards, and 30 states achieved a grade of C or higher while the 20 remaining states scored a D or an F (Vazquez, 2017). The highest score awarded to New Hampshire due to the presence of

evolutionary standards in elementary school and following 15 states received the lowest scores awarded—predominantly in the southeastern portion of the country—Georgia, Mississippi, Ohio, Arkansas, Indiana, Louisiana, South Carolina, Virginia, Tennessee, Idaho, Montana, Nebraska, Texas, Wisconsin, and Arizona. While the results of this study are hopeful for proponents of evolution, the presence of evolution in the standards did not guarantee inclusion in classroom practices (Lynn et al., 2017; Vazquez, 2017). The trend towards evolution becoming more widely accepted is apparent in recent studies.

The presence of evolutionary theory in state and national standards has been supportive of evolution education but does not mean the theory has been taught adequately due to teacher autonomy and the need for more professional development programs (Lynn et al., 2017; Vazquez, 2017). Lynn et al. (2017) found that teachers do make curricular decisions based on personal beliefs and perceived beliefs of their students, colleagues, and community members. The decision of biology teachers to bypass standards due to personal beliefs are present in several studies creating a specialized niche for professional development (Friedrichsen et al., 2016; Goldston & Kyzer, 2009; Sickel & Friedrichsen, 2018).

Avoidance

When a teacher's worldview conflicts with research, the teachers have chosen to avoid the subject to reduce contention. Berkman and Plutzer (2015) surveyed 926 biology teachers from 49 states with a six-page questionnaire to gauge perceptions of evolution education. These researchers found that most teachers surveyed entered the classroom without resolving personal conflicts between faith and evolution, which led to avoidance of the basis of biology that is evolution. A negotiation of barriers was echoed by teachers who stated that the method of delivery was more important than the teachers' pedagogical content knowledge. However, results

from the survey suggested that teachers with higher content knowledge delivered a more rigorous curriculum (Berkman & Plutzer, 2015).

Human Evolution

An underrepresentation of human evolution exists by teachers of and life sciences (Bayer & Luberda, 2016; Beggrow & Sbeglia, 2019; Pobiner et al., 2018). In a quantitative correlational study, undergraduate students (n = 268) took a questionnaire to gauge evolutionary knowledge and, specifically, human evolution. Biology students and anthropology students scored novice-like in the understanding of evolutionary concepts and human evolution, suggesting a lack of preparation in K–12 contextually (Beggrow & Sbeglia, 2019). A review of the research suggests that teachers need, desire, and benefit from professional development opportunities, specifically those designed to train in controversial issues such as human evolution. Cognitive science researchers suggested the use of human evolution to teach evolution by science teachers presents a connection to evolutionary change, making learning more relative (Beggrow & Sbeglia, 2019). This study will address gaps concerning middle school science teachers with an awareness of barriers to include environmental changes, standards-driven curriculum, and a need for professional development regarding evolution education.

Need for Professional Development

A growing concern for scientific literacy correlates with a lack of understanding of evolutionary theory from science teachers nationwide (Borgerding et al., 2015; Hermann, 2018). An understanding and acceptance of evolution among those responsible for teaching the content are crucial to making connections of scientific knowledge with scientific literacy to teach future generations effectively. According to a study of 276 secondary biology teachers from Missouri, teachers expressed a need for professional development regarding evolutionary theory (Romine

et al., 2014). Researchers surveyed to understand the needs of biology teachers to structure professional development opportunities appropriately. A study by Ha, Baldwin, and Nehm (2015) investigated the effect of professional development regarding the knowledge and acceptance of evolution with 28 K–12 teachers. These researchers employed pre and posttests in a year and a half long study. They concluded that well-designed professional development opportunities led to significant increases in acceptance and understanding of evolutionary sciences among participants (Ha et al., 2015). Teachers require additional training in controversial areas such as evolutionary sciences to prepare for challenges that often accompany such topics.

Professional development allows administrators to address cognitive dissonance in the realm of evolution education and to brainstorm practices of transformation. Professional development becomes transformative when it creates safe spaces to open minds for effective change (Mezirow, 1991). Dissonance describes how belief systems affect actions. These studies focus on teachers of biology and students, first-year teachers, and college professors of biology with no mention of life science teachers who are equally responsible for evolution education. The focus of this research is to fill the gap of qualitative research to learn and share the stories of middle school life science teachers of evolution.

Quality Professional Development Programs

Misconceptions concerning evolutionary theory is a significant barrier for biology teachers and college professors (Beggrow & Sbeglia, 2019; Gregory, 2009; Heddy & Sinatra, 2013). Matthews (2012) recommended viewing pedagogical content knowledge through the lens of knowledge enhancement to identify and address existing misconceptions. Quality professional

development programs allow teachers to address common misconceptions that permeate the controversial topic of evolution.

Sickel and Friedrichsen (2018) found that by viewing the content knowledge and practice of science teachers from various lenses, an accurate depiction of the nature of science surfaces (Matthews, 2012). Results from this literature review revealed a need for access to topic-specific resources to enhance the quality of evolution education for science teachers. For a further contribution of teacher's pedagogical content knowledge, Ha et al. (2015) suggested more effort by the science education community to provide evidence-based phenomenon as proof of evolutionary processes. Well-designed resources made accessible to science teachers will be beneficial to teachers and students.

Educators are provided with a list of state and national standards to serve as a curricular guideline directive of lesson planning (Vazquez, 2017). However, teachers reduce time spent on educational standards that conflict with personal ideology, linked to a phenomenon known as cognitive dissonance (Ball & Cohen, 1999; Glaze, 2018). In a study by Bland and Morrison (2015), detection of physiological responses in participants of evolutionary studies who displayed signs of anxiety when asked about evolutionary concepts. In this study, 33 participants deployed a Lafayette model polygraph instrument while monitoring heart rates. The presence of dissonance occurred in the physiological detections observed in participants (Bland & Morrison, 2015). The results led researchers to suggest levels of cognitive dissonance as a factor for heightened emotions during the study of evolution. Developing a more in-depth understanding of dissonance provides a foundation to build a relationship with those in opposition to solid science in a non-combative manner.

Determining barriers causing a lack of preparedness to teach evolution among science teachers was the purpose of a few studies in the U.S. (Nadelson & Nadelson, 2010; Rutledge & Warden, 2000). A mixed-method study of K–8 biology teachers (n = 68) with a master's degree utilized a longitudinal study (n = 350) to report perceptions from teachers who stated they felt underprepared to teach evolution (Nadelson & Nadelson, 2010). The need to enhance training for science teachers responsible for teaching evolution has been suggested by teachers feeling underprepared.

The current state of pedagogical content knowledge among science teachers suggested a specific need for training in evolution education (Bravo & Cofré, 2016; Friedrichsen et al., 2018). Professional development training sessions were designed to offer new teaching and learning materials and highlight best teaching practices to improve content knowledge (Friedrichsen et al., 2016). Researchers suggested additional resources and training for those teaching controversial topics, specifically to enhance pedagogical content knowledge of evolution (Bravo & Cofré, 2016).

To better understand the needs of biology teachers, a quantitative analysis was administered with 276 secondary biology teachers using 33 Likert-type questions in an online survey (Friedrichsen et al., 2016). In this study, biology teachers self-reported a need for training specific to evolutionary biology. They listed the topic of *human* evolution as the most negated of all topics specific to the field of evolution. Researchers achieved a significant sample size, although no evidence explained why teachers feel underprepared or why they negated certain aspects of evolution, such as *human* evolution. A narrative inquiry design allowed meanings and explanations of stories of teaching evolution.

Review of Methodological Issues

A review of various research methods utilized in empirical studies shed light on the advantages and limitations of quantitative and qualitative methods. In this section, studies offered an analysis regarding the chosen methodology by examining the evidence concluded. The studies reviewed provided a comprehensive review of the types of research regarding the teaching of evolution in K–12 and college courses.

Quantitative Issues

Quantitative research is a direct process used to gather precise and quantifiable data to test a hypothesis (Creswell, 2014). In this method of cause and effect data collection, the researcher has a point of focus to prove or disprove answers to specific questions. Romine et al. (2014) conducted a quantitative investigation of the result of professional development for teachers of biology and which exposed shortcomings of evolution education. Science teachers in the Romine et al. (2014) study the self-reported minimal understanding of evolutionary concepts and requested additional professional development for evolution education. The limitations of quantitative studies lie within abstract data such as human behaviors. Quantitative software is useful for gathering large sums of data to answer specific questions but is unable to assist researchers in determining how or why a phenomenon occurs.

Qualitative Issues

Many study designs included qualitative data in the form of surveys, interviews, questionnaires, observations, and self-reflection. These methods raised questions to examine the quality of various study designs and to measure the effectiveness in the realm of teachers of evolution education. In an intimate study of two in-service secondary biology teachers, research portrayed how teachers engage in complex topics such as evolution (Bravo & Cofré, 2016). In

this qualitative study, teacher observation occurred. They interviewed to determine that professional development prompted a shift in teachers' pedagogical content knowledge to improve teaching strategies and methods to teach evolution.

The key to bringing substance to a qualitative narrative design is the level of rigor and dedication delivered by the researcher (Clandinin, 2007). Additionally, a narrative inquirer should possess a solid background of content knowledge concerning the nature of the topic to best grasp the stories others have to tell (Kim, 2016). Stories were gained and retold with biases and limitations. The focus of qualitative studies included 13 studies regarding biology teachers. In contrast, no studies to date have sought to understand the stories of *middle* school life science teachers responsible for teaching evolution.

Mixed Methodological Issues

Not all data are measurable but falls on a continuum. Placing research on a continuum provides the freedom to incorporate varying levels of quantitative and qualitative procedures while gathering research. A mixed-method approach placed no hierarchy on either approach, yet typically uses a higher percentage of either quantitative or qualitative analysis (Creswell, 2014). The use of surveys and questionnaires has been a common way to gain data from large sample sizes and occurs in both quantitative and qualitative analysis (Ponto, 2015). The convenience of surveys has allowed professionals, such as teachers, to answer questions promptly using web-based services. SurveyMonkey and Qualtrics are two standard web-based services that offer surveys online. A downside to gaining high response rates in surveys has been the limited amount of information to gain an independent setting (Nadelson & Nadelson, 2010)**.** Four recommendations to reduce error with surveys are a multimode approach, diverse and random

sampling methods, valid and reliable instrumentation, and providing a user-friendly survey design (Ponto, 2015).

Synthesis of Research Findings

A close investigation of the literature review has suggested that science teachers face significant barriers during evolution education (Barnes & Brownell, 2016; Hall & Woika, 2018; Pobiner et al., 2018). Barriers led to reduced quality of evolution instruction with little to no mention of *human* evolution (Cofré et al., 2017; Glaze, 2018; Pobiner, 2016). A review of the studies presented focused on biology teachers and college professors without research available for middle school science teachers (Borgerding & Deniz, 2018). Therefore, added analysis of these studies endorses the need to expand research to teachers of younger demographics (Vazquez, 2017). Researchers have studied the behavior of science teachers using phenomenological studies designed to understand the lived experiences and perspectives of participants of evolution education (Glaze, 2018; Goldston & Kyzer, 2009). Few studies provide a detailed inquiry of science teachers for lengthy periods as conducted within the scope of narrative inquiry, and no studies to date provide narratives of middle school science teachers regarding *human* evolution education.

A review of the research, utilized by those within the evolution education field, determined those narrative inquiries were sparse in the research explanation process. The research, as seen by those within the discipline of evolution education, found the practice of design-based research positioned to have a practical impact on teaching practices (Pobiner et al., 2018). Thus, a need for more qualitative research is needed to reveal in-depth collections of data through consideration of how and why the phenomenon was influenced (Baxter & Jack, 2008).

Further inspection of studies in the literature review presented two prevalent themes of evolution education to include the presence of worldviews and a lack of teacher training. These themes centered on complex interactions pitting worldviews in conflict with the nature of science and evolution education (Bravo & Cofré, 2016; Glaze, 2018; Glaze & Goldston, 2015; Pobiner et al., 2018). Results from researchers in these studies suggested low levels of teacher aptitude of the content due to a lack of training and a presence of dissonance (Bland & Morrison, 2015; Glaze, 2018). A lack of training to prepare science teachers for evolution education was suggested by researchers (Berkman & Plutzer, 2015; Bramschreiber, 2014; Bravo & Cofré, 2016; Cofré et al., 2017; Short & Hawley, 2015) who cited a need for thematic units and hands-on activities (Vazquez & Freidhoff, 2017).

One study, dedicated to science teacher needs, conducted a 3-year study which offered self-reports from teachers who suggested the need to enhance teacher pedagogical content knowledge to benefit themselves, their students, and the curriculum (Zhang et al., 2015). Researchers from this study supported the need for professional development for biology teachers with no mention of middle school life science teachers. This missing demographic advocated the need for the narrative inquiry to focus on the stories of those teaching the science of evolution.

Critique of Previous Research

The argumentation for this literature review derives from a presence of cognitive dissonance suggested to be present in biology science teachers nationwide. Reduced content knowledge coupled with misconceptions found within pedagogical content knowledge of science teachers has thwarted evolution education (Sickel & Friedrichsen, 2013). Pedagogical content knowledge is further compromised by cognitive dissonance, which states that educators will

bypass a topic that conflicts with personal worldviews (Bland & Morrison, 2015). The focus of cognitive dissonance and pedagogical content knowledge allows educators to offer transformative teaching in evolution education. Cognitive dissonance contends that evolution education is compromised regardless of scientific validity resulting in isolation from scientific progression.

Existing research contains a central theme regarding evolution education, which is to reduce avoidance of the topic. Researchers have signified a need for science teachers to acknowledge the controversy surrounding evolution education by allowing an open forum of discussion (Bravo & Cofré, 2016). A descriptive statistics study by Colston and Ivey (2015) used grounded theory and found that without demystifying controversial issues, notions of scientific validity could weaken in science educators. Many researchers examined biology teachers (Bravo & Cofré, 2016; Goldston & Kyzer, 2009; Sickel & Friedrichsen, 2018), yet no studies to date detailed the stories of middle school teachers of life sciences. Therefore, the significance of the narrative inquiry of this demographic was deemed necessary for the exploration of middle school science teachers.

Much of the existing research on evolution education has been survey-based. This study design confirmed a lack of understanding and acceptance of evolutionary science (Larkin & Perry-Ryder, 2015) among biology teachers in the U.S. Washington D.C. is the only state of 50 to effectively include evolution education into state standards before the adoption of NGSS (Vazquez, 2017). Most studies focus on secondary biology teachers within a secondary school setting. The lack of research is apparent regarding the stories of middle school life science teachers who recently incurred evolutionary theory among states implanting NGSS.

Two hundred and seventy-six high school biology teachers were surveyed on perceived barriers of teaching and questioned on needs for professional development (Friedrichsen et al., 2016). This survey provided teacher responses to 33 specific questions using Qualtrics as an online survey tool. Researchers reported that participants experienced increased measures to incorporate non-scientific alternatives to evolutionary theory or to skip the unit on evolution altogether (Friedrichsen et al., 2016). The study did not provide descriptions about the nature of these experiences. Additionally, there were no details about how this affected the teacher's ethical concerns for teaching only part of the state and nationally mandated curriculum.

Romine et al. (2014) provided a model to simplify professional development needs and cited pedagogical content knowledge as the most significant factor in evolution education. To strengthen this study, Romine et al. (2014) should have considered worldviews from various religions to gauge the effectiveness of teacher acceptance of evolution and question methods for cooperating with anti-evolutionary ideas (Glaze, 2018; Pobiner et al., 2018). Merging quality professional development to enhance pedagogical content knowledge along with religious sensitivity components are steps suggested to provide quality science education.

Mezirow (1991) described transformative experiences as best found within a diverse group of people and ideas. Based on the literature surveyed, concentration on the disciplinary framework of *human* evolution could assist the understanding of evolutionary theory by providing a personal connection to biology (Beggrow & Sbeglia, 2019; Pobiner et al., 2018). The use of extinct human ancestors, such as *Homo neanderthal*, expands worldviews of biology participants. A key factor to being transformative is the expansion of diverse views that may conflict with personal ideology (Mezirow, 1991).

Chapter 2 Summary

This literature review revealed a united front from researchers who concluded a host of complexities—avoidance, dissonance, legal pressures, and teacher preparation—found to accompany evolution education (Beggrow & Sbeglia, 2019; Hall & Woika, 2018; Pobiner et al., 2018). Additionally, researchers reported unity among teachers who self-reported they are underprepared to teach the theory of evolution (Cofré et al., 2017; Griffith & Brem, 2004). In the *Conceptual Framework* section, a relationship was proposed between cognitive dissonance and evolution education, therefore, providing a case for enhancing scientific literacy. The influence of pedagogical content knowledge and the use of cognitive dissonance provided the evidence needed to frame this study. The *Historical Background of Evolution Education* section highlighted prior court cases, recent bills introduced and described the significance of scientific literacy as positioned by NGSS (Krajcik et al., 2014).

Chapter 3 will describe methods used to gain insight into the stories of 10 middle school life science teachers. Through extensive interviews, stories gathered from veteran middle school science teachers stated they include evolution into their curriculum. These stories were retold to unfold vividly expressive details of middle school science teacher's stories throughout the teaching of evolution and to include the specific topic of human evolution.

Chapter 3: Methodology

Introduction to Chapter 3

Through inquiry, stories of science teachers have been explored from those who taught evolution in public middle schools. The conceptual framework provided the lenses to retell the stories of teachers who engaged in evolution education, namely the theory of cognitive dissonance. Dissonance suggested an implicit disconnect between belief systems and observable actions (Bland & Morrison, 2015). This phenomenon was observed in biology teachers and college professors, as suggested by several researchers (Bland & Morrison, 2015; Mead et al., 2017). Thirty-three participants from a university in Arkansas revealed a measurable physiological change in biology students under controlled conditions. The participants exemplified feelings of discomfort during the mention of evolution education (Bland & Morrison, 2015). The suggestion of cognitive dissonance stimulated an emotional response serving as a barrier to learning about and accepting evolution, and therefore has served as a lens to collect narrative data.

Science teachers have faced a multitude of barriers to teaching human evolution (Borgerding & Deniz, 2018; Lynn et al., 2017). The goal of narrative inquiry—used to gain and understand stories—was to learn from those who may or may not have struggled to incorporate the foundation of biology that is evolution. The use of narrative inquiry was the method of choice by researchers to reveal how teachers have experienced evolution and to gain a deeper understanding with the use of clarifying questions that are unique to the narrative process (Glaze, 2018; Goldston & Kyzer, 2009). The most significant benefit of narrative inquiry has come with the ability to reveal discrete feelings from participants who share a common phenomenon (Kim,

2016). Narrative inquiry design allowed a collection of detailed stories of those teaching evolution in middle school sciences.

The choice of inquiry design resulted in a unique understanding of stories of those teaching evolutionary sciences in a middle school setting in the Pacific Northwest. Biology teachers of evolution have experienced barriers due to the controversial nature of evolution conflicting with religiosity (Borgerding & Deniz, 2018; Lynn et al., 2017). Through an exploration of storied narrated, events of evolution education were revealed. The intricate stories of teachers of evolution offered insight to disclose specific teaching practices, external and internal challenges, and the level of support from colleagues and administrators.

Narrative inquiry was chosen as a methodology to learn the stories of those teaching of evolution in public middle schools. Researchers of other qualitative methods used surveys and questionnaires to obtain surface-level data from closed-ended questions. Alternatively, the narrative process gave the flexibility to direct questions based on participant response to elaborate beyond initial responses. The advantage of a narrative inquiry design compared to other qualitative methods is to understand and retell vivid and expressive stories (Clandinin, 2007). Open-ended questions allowed participants to disclose stories to their entirety. Dialogue and discourse were recorded to create timelines of contextual events as reported by participants during interview processes. Pathways of personal and professional events were negotiated collaboratively during each phase of the research to present authentic stories.

As a narrative inquirer, consideration of personal and professional experiences was reflected before gaining knowledge from others (Clandinin, 2007). The implications of biases were considered to identify a presence of cognitive dissonance within the nature of the study. The use of narrative inquiry provided a comprehensive approach to gather detailed information

about each teacher's story who expressed challenges of teaching evolution. The phenomenon of teaching evolution as a collection of events provided a comprehensive overview of teaching evolution from teachers of middle school sciences.

This chapter has included steps used to choose study participants and a strategic plan to gather and analyze data. In addition, an informed consent form, confidentiality procedures, the selected population, data collection methods and analysis, ethical concerns, and validity and reliability measures were included in this chapter. Instrumentation, data collection procedures, and limitations of a narrative design reveal how data has been obtained.

Research Questions

Worldviews—when inconsistent with the acceptance of evolution among science teachers—require science reform efforts to be inclusive of religious sensitivity to make progress towards scientific literacy (Glaze, 2018; Pobiner, 2016). The use of dissonance as a lens to view participant stories afforded a sense of empathy to overcome biases (Bland & Morrison, 2015). From this framework, the following five questions brought focus to the study:

RQ1: What are the stories of science teachers teaching evolution in middle schools?

RQ2: What do the stories of middle school science teachers reveal about the practice of teaching evolution?

RQ3: What challenges, if any, have science teachers experienced or perceived while teaching evolution?

RQ4: What do the stories of science teachers reveal about administrative support regarding evolution education?

RQ5: What do the stories of science teachers reveal about support from colleagues regarding evolution education?

Purpose and Design of the Study

The purpose of this qualitative study with a narrative inquiry design was to explore the stories of science teachers teaching evolution in middle schools. A qualitative method design was chosen over quantitative data to learn storied events that occurred among middle school science teachers. The choice of narrative inquiry came from the desire to know detailed events of evolution education in a middle school science classroom.

The choice of case study methodology was rejected to gain individual stories from each teacher. Additionally, a grounded theory approach was not selected since in grounded theory research the viewpoint of participants is gained through many types of data collection. Alternatively, the choice of narrative inquiry centers on gaining stories primarily throughout interview processes to unveil deeper meanings from participants (Creswell, 2014). Grounded theory was excluded since the researcher did not seek to generate theory. The goal of this research was sought to tell events as participants reported them during the interview process. A phenomenological approach was considered and rejected since the goal of this research is to seek to understand experiences. Ethnography research design was not considered since this type of research focuses on group culture. The goal of narrative is to gain elaborative details gaining a comprehensive story from a chosen demographic.

To best represent each participant's story, data were categorized into one of several genres. Narrative genres include (a) biography, (b) autobiography, (c) art-based, (d) literary-based, (e) creative fiction, and (f) visual-based (Kim, 2016). A narrative design was concluded as most compatible with the research design, along with a biographical genre blended with an autobiographical genre to make connections with participants—these genres best aligned with the goal of understanding stories of all participants involved in the study. During transcription of

research texts, the researcher analyzed to maintain authenticity to convey stories that were compelling and illuminative (Clandinin, 2006). Negotiations and renegotiations have served as a dual role to situate and resituate data (Kim, 2016). The process of negotiating the data described follow-up questions were formed throughout the interview processes. The narrative researcher followed a two-fold task of reworking stories just as they were reported with the challenge of writing creatively (Clandinin & Huber, 2010). A balance of stories from the participants of this study combined several decades of experience of teaching evolution in middle school.

The power of storytelling, through narrative inquiry in a scholarly fashion, offered a balance of artistry blended with philosophical and methodological underpinnings (Kim, 2016). The prose was organized into a plot to retell stories in a manner of appreciation and genuineness free of authoritative writing found in other scholarly methods. Narrative writing humanized participants to gain access to extenuating details (Kim & Latta, 2009). Through a thematic style of writing, a discovery was made of how and why actions occurred, which reduced assumptions and distorted confines between truths and falsehoods (Kim, 2016). This model of data collection focused on communication, where participants felt safe, open, and honest about the journey of storytelling (Parker et al., 2017). The strength of collaboration was dependent upon the ability to establish a personal connection with participants through reflective practices (Kim, 2016). The practice of reflection allowed consideration of a personal perspective. The presence of humanity throughout the interview process created a space where narrative authority was bestowed on the interviewees to tell their stories (Clandinin, 2006). Detailed accounts and events were revealed to determine the presence and types of challenges that existed among middle school science teachers. Specifically, milestone events that shaped the teaching philosophy of participants

regarding the theory of evolution were told with an additional focus on the inclusion of human evolution.

The uniqueness of narrative inquiry was the absence of problem-solving measures found in quantitative research (Clandinin, 2006). The missing component of advocacy afforded a sense of freedom to be open-minded enough to consider alternative viewpoints (Kim, 2016). These liberties are absent in quantitative study designs that seek to test a hypothesis (Creswell, 2014). Within the design of narrative inquiry, the narrative *is* the phenomenon (Clandinin, 2007). These stories became the data which was organized and analyzed. Stories provided vivid details of each participant's journey within the context of evolution education. The dialogue from participants offered a unique opportunity for personal and professional growth through reflection of teaching practices. Through a discussion of contextual events, participants reflected and considered how they approached the teaching of evolution. The telling and retelling of these stories may have led to transformative experiences for participants to gain new insight into current teaching practices (Mezirow, 1991). Reflection of lived experiences helps shape worldviews requiring patience and practice during the narrative inquiry process.

The use of a narrative study design required the researcher to exercise the skills of being a skilled listener and storyteller (Kim, 2016). These attributes were imperative towards gaining a real sense of each participant's stories. Stories were recorded in chronological order to include climatic events of transformation (Mezirow, 1991). The safety of participants was a continual priority by disclosing privacy procedures and the nature of narrative inquiry before the interview process. Confidentiality protected the privacy of participants and to build honesty for attaining accurate depictions of stories. Participants were informed of the nature of narrative inquiry as being free of evaluative measures and judgment, which offered teachers a space to tell

their story honestly and openly in their own words. In addition, the narrative design illuminated the power of reflective practices as the teacher recounted events that led to current perspectives (Clandinin, 2007).

A relaxed environment was fostered by giving pause to participants and allowing enough time to ponder answers without being rushed. Creating such an environment, circles of trust formed among participants in which freedoms of expression flourished (Palmer, 2009). This method presented new levels of awareness to the humanity of teaching as access to each story was achieved. Clandinin (2007) maintained that perceptions of participants could be transformative on various levels throughout each interaction of the narrative inquiry process. The atmosphere of an interview process contrasted with typical conversations by giving participants the stage to describe events and to a researcher prepared to receive stories equipped with thought-provoking questions.

Researchers of narrative inquiry blend lived events with those of each participant to actively engage the researcher (Clandinin, 2007). However, narrative interviews were less structured and required the interviewer to be delicately engaged. The act of being a good listener required the interviewee to narrate with few interjections to gain accurate and comprehensive depictions of stories (Kim, 2016). Before collecting narratives from teachers, criteria included participants who agree they adhered to the NGSS curriculum. Additionally, criteria were set to narrow the scope of participants to those experienced in teaching evolution to ensure that each participant related to the study contextually.

Research Population and Sampling Method

This study followed a narrative research design to explore stories of teaching the topic of evolution. Before interviewing, participants were chosen who best fit the criteria of the study,

and the development of an interview protocol (Creswell, 2014). Purposive sampling was used to choose participants based on the criteria of teaching evolution in a public middle school who have taught for at least 10 years. A decade of experience was chosen as a parameter to gain participants with adequate teaching experience to tell vivid stories of teaching evolution. The population used for this research were middle school science teachers in the Pacific Northwest. Participants were selected from different regions of the state. By choosing teachers from schools in urban, suburban, and rural communities in the Pacific Northwest, data are representative of diverse populations. The choice of researching in a state that has implemented the NGSS provided a population of middle school science teachers who had evolution embedded in science standards.

Qualitative researchers debated a specific number of participants to interview for a narrative inquiry process. However, they agreed that the sample size of interviewees should be small enough to focus on collecting in-depth life stories (Kim, 2016). A sample size of 10 teachers offered a limited perspective on the stories from teachers in evolution education at the middle school level. A further advantage was time to gain rich details in multiple exchanges. Fewer participants afford focus to analyze and rewrite stories scholarly and provocatively (Kim, 2016). In this sense, a more in-depth understanding was gained of events and how they fit contextually in the study (Polkinghorne, 2007). The focus of fewer teachers and more time per teacher allowed more time to achieve a collaborative narrative experience (Clandinin, 2006). Having 10 participants was a small enough sample size to gain access to each participant multiple times, yet large enough to gather rich details of stories of those who taught evolution in a middle school setting.

To meet the goal of 10 teachers, science teachers with a minimum of 10 years teaching experience who currently teach, taught in the past, or retired teachers of middle school science were secured. Purposive sampling allowed researchers to choose participants who fell within the criteria of the study to gain the most substantial results (Yin, 2011). Participants were sought at an annual Oregon State Science Teacher Conference. Teachers interested in participating in the study were given an email address to inquire. Participants chosen were public middle school science teachers with 10 or more years of experience in the Pacific Northwest. I attend this science conference each year and have developed a rapport with the middle school science teacher presenters. The conference averaged 25 presenters and 150 science teachers.

Teachers who attended this conference were public school science teachers, 18 years or older, and taught in the Pacific Northwest. Potential research participants were recruited by handing out flyers to middle school science teachers and were asked to send an email if interested in participating in the study. The flyer contained information requesting teachers with 10 or more years' experience teaching evolution in a public middle school (see Appendix A). If the desired population were unmet within one week of the conference, flyers would be reposted to advertise the study and the need for middle school science teachers of evolution education to participate. The administrator of the Teacher Institute for Evolutionary Science permitted attendance of this event to pass out flyers that advertised the study. These flyers were posted at locations that teachers frequent, including coffee shops, libraries, and grocery stores, to reach a sample size of 10 participants for the interview process.

Interviews were kept within a 30-minute to one hour for the initial interview and each follow-up interview via phone, email, or an online video chat application. Honoring the value of participants' time remained essential. Teaching occurs in a busy environment in which the role

of productivity remains central, and teachers are less familiar with discussing academic content and taking time to reflect on knowledge (Clandinin, 2007). Some participants provided comprehensive details about the teaching of evolution within the initial interview. After the initial transcription of each interview, follow-up questions provided elaboration of areas unclear or in need of further explanation.

In contrast, others required several emails for follow-up questions to gain the most considerable depth of detail. Participants were informed they could at any time withdraw from the study, skip an answer to a question, or postpone an answer to any question. Interviews were transcribed, and a copy was provided to participants via email to make changes or clarify statements as needed. Follow-up questions were necessary for five of the 10 participants. Transcription of interviews were sent to participants for editing and analyzed. Participants were given the option to meet using a live internet video feed or by meeting face-to-face in a public library. However, face to face meetings was encouraged to enhance levels of connectivity and collaboration.

Teaching is a fast-paced profession in which relaxed conversations are a rarity (Levin & Wadmany, 2006). Therefore, times were honored and valued to gain in-depth depictions of each participant held on lived events of evolution education while respecting challenges. Data were collected throughout extensive interviews within a setting in which interviewees felt most familiar. Natural settings were considered to empower participants and to build meaningful relationships (Kim, 2016). These interviews occurred before or after the teacher's contracted time with the school district and took place off-campus. There was no compensation for participants who were reminded they were under no obligation to give of personal time to be interviewed voluntarily.

Follow-up meetings were scheduled with two participants to ask extenuating questions relative to the study. Interviews were taped using a cell phone application to include the participant's consent for future transcription and examination. The laptop used during the interview served as a secondary back-up for recording each interview. To reduce attrition rates, awareness of the 'Observer's Paradox' was considered to continually collect data throughout the research process, regardless of personal influence and challenges (Kim, 2016). Participants who preferred a phone interview were granted, and a date and time were arranged and confirmed through email. Communication occurred primarily through email for accountability and recordkeeping measures to enhance the validity of the study. Maintaining a prominent level of respect to learn, transform, and share the stories of participants permeated focus throughout this research process.

Kim and Latta (2009) indicate that quality research has occurred once trustworthiness is established. To build circles of trust (Palmer, 2009), emails and phone conversations created lines of communication and established openness among participants. Given personal experience as a veteran teacher, the common ground of evolution education served as a springboard into conversations during collaboration. The inquiry, however, adapted to changing roles as relationships naturally became reactive throughout the study (Kim & Latta, 2009). The continuum between being a good listener and fulfilling the role of an active participant in the study required careful consideration.

A cooperative management plan contained an informed consent form (see Appendix B). This appendix included a timeline of goals and a written reminder that all participants retain their rights to remove themselves from the study prior to publication. The informed consent form included the purpose of the study, the level of participation requested, the choice of

confidentiality, permission to record interviews, and participant expectations. Furthermore, the form stated that participation remained voluntary and without coercion or financial gain for all participants. Participants who were unable or willing to participate or those who withdraw from the study received an email thanking them for their time. An informed consent form included detailed steps taken to record and secure all data throughout the study and measures taken to remove data once the study is finalized. The informed consent form was delivered to each participant via email once they agreed to participate in the study. The use of a comprehensive cooperative management plan protected affiliates, participants, and improved the validity of the study.

To ensure privacy, discretion measures included assignment of pseudonyms for each participant to be repeated on all documentation. The importance of confidentiality has been crucial and ongoing throughout the investigation as well as a lifelong process upheld in a manner of respectful representation of all participants (Clandinin, 2007). The dissertation was written for participants using confidentiality. Confidentiality was considered a vital component of this study to remain sensitive to the participants' privacy due to the historical controversial of the topic and extensive details as typical of narrative design.

The measures taken to gain authentic stories of evolution education that flow naturally from participants include careful consideration of the quality and quantity of questions asked. Active researchers pinpoint events of concern and passion without prodding participants towards expected outcomes (Clandinin, 2007). Less direction given by the interviewer, allowed more autonomy for the interviewee to include specific details. In addition, reminding participants that the research is non-evaluative in manner has created stronger ties of trust and authenticity (Kim & Latta, 2009). Public school teachers are familiar with being evaluated and rarely, if ever,

consulted to describe pathways of events (Levin & Wadmany, 2006). Remaining flexible, honest, reliable, and honing communication skills were hallmarks to sustain initial and long-term participation from participants.

A unique challenge to build relationships of interconnectivity dug deeper into the individual layers of each participant's life events. The benefit of using narrative inquiry as a research design permitted access through collaborative efforts into the complex layers of non-linear events that shape one's perspective (Clandinin, 2006; Yin, 2011). A significant goal of a narrative inquirer is to be a good listener while pausing to give participants time to articulate thoughts. The panacea of inquiry has come with the task of honoring each participant while authentically unfolding the stories (Kim, 2016). Through patience and perseverance, pivotal details illuminated events to shed light on stories of those tasked with teaching evolution.

Instrumentation

Instrumentation included semistructured interviews—optimal for storytelling—as the primary tool to collect data using open-ended questions aligned with initial research questions. Interview questions were generated and asked in unstructured interviews to engage each participant to describe intimate details regarding stories of teaching evolution in a middle school setting. Semistructured interviews have afforded a conversational tone allowing the interviewer and interviewee to speak candidly, openly, and honestly (Kim, 2016). A framework was built out of a few questions while remaining flexible enough for participants to divulge unanticipated details within each interview. Each question determined events to story how participants have experienced the teaching of the theory of evolution. Questions were written to determine if, what, and how challenges existed for teachers along with support measures that influenced teaching practices of evolution.

To validate interview questions, a set of field questions were peer-reviewed. Field testing was utilized to reduce bias. Once interview questions were generated and approved by the committee, three participants of evolution education field-tested questions to provide comprehensive feedback. Field-testing allows a novice researcher to collaborate with those more experienced in the field to create quality interview questions (Kim, 2016). Questions were field-tested upon Concordia University–Portland Institutional Review Board (IRB) approval. The choice of three researchers in the field of evolution education field-tested questions. The process of field-testing questions assisted in making revisions based on limitations and weaknesses determined in the questions by the field-testers.

Once questions were field-tested, analyzed, and revised, interviews were scheduled. Data from interviews were sourced during each one-on-one interview. Open-ended questions allowed the interviewer to keep the dialogue centered on the teaching of evolution while using the lens of cognitive dissonance to discern dialogue. The questions were designed in a semistructured, non-theoretical language to elicit extenuating details. Interview questions were field-tested using the following questions:

1. Please tell me the story of how you became a science teacher.
2. Which events were most impactful that led you to the field of science?
3. Please share with me the story of who has been most influential in your science teaching career.
4. Could you share with me a few stories of teaching evolution in the middle school over the past 10 years?
5. Please tell me the story of *how* you prepare to teach the theory of evolution.

6. How would you describe the most memorable events in the past 10 years of teaching evolution?
7. If applicable, could you describe how you incorporate *human* evolution into the topic of evolution?
8. Have there been instances where you felt empowered or limited by administrators in your teaching practice regarding evolution?
9. Have you ever sought out support from colleagues regarding the teaching of evolution?
10. Have there been any challenges in teaching evolution in your experience? If yes, would you share the story with me?

Alternatively, a structured interview—referred to as an oral questionnaire—contained specific questions to be answered (Bold, 2012). The choice of semistructured questions was chosen to afford fluidity. The use of semistructured interviewing gave the interviewee space to naturally tell their story with limited influence from the interviewer (Kim, 2016). Gaining the full story is the most challenging aspect for a researcher of narrative inquiry is to create questions that are so well-written, they access ideas even the participants were unaware of (Kim, 2016). The goal of the narrative was to reveal the underpinnings of what participants were genuinely thinking and feeling.

Data Collection

Data were collected after IRB approval was received. Participants received an introductory letter that described the study and welcomed them to the research process. Once a response was received, a date and time were requested for interviews. Each interview began with the same set of semistructured questions but took the direction based on the interviewee's

responses. Interpretation of data throughout the interview process and to navigate the choice of questioning. Narrative inquiry is a reflexive process used to gain a comprehensive understanding of participants through negotiations. That is, the process demanded continued consideration of how data related to personal experience.

After each interview, hand-written notes were recorded regarding reflective thoughts of interview effectiveness was conducted to analyze what worked well and what needed to be improved. The interview processes were the primary method of data collection to explore the many-faceted thought-processes of participants that would go unnoticed through observations—interviewing allowed the meanings behind stories to be revealed.

Before writing interview questions, I reflected on how and why these questions were going to be asked and began the first question with a general open-ended question to give the interviewee a chance to tell a story with limited guidance. Interview questions began with a broad question to place the interviewee into the study to allow the use of follow-up questions to probe participants to elaborate contextually. Some responses required follow-up questions for elaboration, clarification, or when participants needed prompting. Interview questions were written to gain events that led up to the participants' worldview and to get a sense of how evolution education affected the lives of middle school science teachers.

Concluding each interview, participants were informed that they would be contacted within two weeks by sending an email of the transcription for review. Interviews were transcribed manually, followed by an email of the transcription to check for accuracy of the content. Member-checking allowed participants to accept or refute interpretations of the transcript to make changes as needed. Participants were informed they could be contacted again

for follow-up questions to clarify or elaborate vital points. Within 24 hours, participants received a thank-you email for participation and reminded of the value of shared data.

A substantial challenge of data collection was the task of making participants feel safe and secure enough to reveal crucial details regarding evolution education. The research site for interviews is critical for the success of the narrative inquiry process (Clandinin, 2007). One-on-one interviews were held in a private meeting room at a public library and was reserved before protecting the privacy of participants and reduce background noises. Meetings occurred either before or after school outside of the teacher's contracted time with the school district. This form of questioning seeks to encourage participants to include copious details of events leading up to the current practice of teaching evolution. The key to excellent interviewing is to ask open-ended questions for the participant to offer an authentic perspective otherwise not considered. The interview process involves a robust collaborative effort for all participants once trust was built (Palmer, 2009). Acting as a blank slate to reserve reflection once the interview is complete is essential to reduce bias. To further reduce bias, gain trustworthiness, and ensure validity, data were gathered firsthand as a primary source of collecting data. The following steps were followed to collect data:

1. Obtain IRB Approval
2. Email Introductory letter and wait for a return
3. Email Informed Consent to the potential participants and remind them they may withdraw at any time.
4. Schedule interview to meet at an agreed-upon local establishment
5. Use a cell phone app for android to record interviews
6. Audio to text as a back up to record each interview

7. Audio to text manually corrected for errors
8. Read for the overall feel and big picture ideas of the interview and take notes in the columns (Creswell, 2014)
9. Consider the underlying meaning of responses to create follow-up questions (Creswell, 2014)
10. Begin broad levels of coding (Creswell, 2014)

Dissemination was included in the consent form to gain permission from participants and to record and analyze stories garnered from each interview. While the use of audio recordings ensured the accuracy of the interview contents, Yin (2011) warned against recording if the interviewee appeared uncomfortable. The privacy of the recordings was discussed to build trust among participants before beginning each interview. By creating a space of comfort, openness, and applying attributes of the study, primary data has been collected more efficiently to be analyzed (Kim, 2016).

Identification of Attributes

Qualitative research requires the researcher to become an instrument of the study (Kim, 2016). The research was affected by a personal story as a middle school science teacher and influenced the interpretation of the data. Attributes considered for this narrative inquiry are the importance of context, the importance of meaning, the researcher as an instrument, and reflexivity.

The importance of the context of this study questioned how truthfully each participant would reveal the stories of teaching evolution. Along with truthfulness, several variables affected participants' answers to the interview questions, including the level of trust, time constraints, personal and emotional state of mind, the quality of questions, and memory recall. Considering

these factors was essential to work towards hosting an interview that is timely, professional, and considerate of participants.

The deep meanings of the storied events were the core of narrative inquiry and what sets the method apart from other forms of qualitative studies. The advantage of narrative inquiry is to go beyond surface-level questions to draw meaning from the data. The advantage of semistructured questions provides flexibility to alter questioning based on participant responses. As a narrative inquirer, stories are gathered, interpreted, and retold. During the data-gathering phase, I was the instrument who collected data to analyze through transcription to retell with accuracy. The relationship between myself and each participant was vital to gain an in-depth understanding of stories teaching evolution.

This study was conducted using reflexivity to consider the background of personal and professional connections to the study and how those stories could influence the study. Reflexivity has been defined as critical reflection through consideration of the personal relationship to the study and to determine how factors could influence the validity of the study (Kim, 2016). This form of ethical research provided an opportunity to reduce bias as an attribute of this study. To further reduce bias, the strategy of bracketing was employed to be mindful of assumptions and work to separate those from stories collected from participants. Additionally, the data collection protocol attributed to reducing bias as interviews were conducted in a manner to gain knowledge and honor participants (Clandinin, 2006). Stories were collected and retold to understand and learn from events reported among teachers of evolution.

Data Analysis Procedures

The stories of teachers were analyzed from several regions of the Pacific Northwest through interviewing. Coding data served as an efficient way to reorganize conversations to

unveil the big picture of patterns contextually relative to the study. However, coding data has led to a decoding process through the identification of subtle events often overlooked by novice researchers (Kim, 2016). Coding with field-tested questions was performed in preparation for this study. Transcriptions should be read several times to reorganize each interview transcript into codes, categories, patterns, and themes (Kim, 2016) to capture an intimate knowledge of this data. Once transcriptions were reviewed thoroughly, data were manually coded to ensure accuracy and completion of retrieving common themes, phrases, and concepts. These steps served as a roadmap to gain accurate depictions of events and minimize assumptions.

After interviews were gathered and recorded, coding and recoding were used to organize contextual phrases into categories to then locate major themes within evolution education among various cultural groups. Further, the dialogue was dissected into a timeline of contextual events. These events were organized into an excel matrix based on themes or patterns of meaning surrounding evolution education as a timeline of events. After themes were contextualized into similar patterns and reordered chronologically, interviews were retold structurally. Themes were used to create visuals of the data in tables, figures, and the final narrative. Codes were assigned to each typed transcript to maintain confidentiality to protect the privacy of participants and organizations as mandated within IRB procedures.

Throughout the process of analysis, data were examined as a curious explorer dedicated to finding both common and rare patterns of events. Data were methodically analyzed to identify barriers and disclose the specifics of support sought and provided by teachers in need. The practice of teaching regarding *human* evolution was revealed within evolution education to determine the presence and professional development needs of his topic for teachers of evolution. The presence of human evolution in biology classrooms has been suggested by

researchers to be beneficial towards evolution education (Beggrow & Sbeglia, 2019). Finally, data were presented to create a resource for administrators and educational leaders to advance the practice of evolution education. Analysis of data revealed categories and themes of how the teaching of evolution was experienced.

Limitations of the Research Design

Despite attempts to address limitations, absolute neutrality is unachievable for researchers. Firsthand experiences as a classroom teacher of evolution who transitioned to working as a presenter of evolution influenced bias and suppositions. The practice of bracketing to reduce assumptions and separate personal experience from experimentation remained limited as these events shaped my worldview. The goal of the qualitative researcher was to go beyond statistical data reported in quantitative research to examine the complexities of humanity. A more significant challenge has existed for qualitative researchers to prove the knowledge claims of research conducted (Kim, 2016). Regardless of the limitations of presenting multiple perspectives without objectivity, I acted as a post-structuralist researcher. Post-structuralism has rejected literal interpretations of language to expose fundamental meanings of conversations and strive to be free of exactness (Kim, 2016). Collective assumptions were challenged as a post-structuralist researcher, and interviews were conducted subjectively to seek the core meaning of storied events. Deconstructing the discourse of dialogue as interviews were coded and decoded has been accomplished (Kim, 2016). Limitations were recognized within the narrative as well as limitations present in my worldviews to employ strategies to diminish probable consequences through the practice of transparency. The limitations of personal and professional biases were addressed regarding the 17 years spent as a participant of evolution education. The practice of transparency through disclosure prompted the inclusion of autobiographical evidence. Remaining

transparent throughout the research process promoted a sense of trust and cooperation with participants.

Validation

Interview questions were field-tested for validity, and member-checking was used to ensure the accuracy of information from participants. Three participants in the field of evolution education field-tested interview questions and offered feedback on how to improve the line of questioning. The act of member checking has required clarification and elaboration of themes and patterns by participants throughout the research process (Borgerding et al., 2015). Once interviews were transcribed, participants received an email of the transcription to check for accuracy by reviewing and making corrections as needed. To reduce the risk of compromised data, working closely with participants to gather true stories has served as a useful tool to ensure the validity of participants' stories (Kim, 2016). Coding data met saturation to the point of repeating patterns in themes among participants while gaining deep meaning in a post-structuralism manner.

Post-structuralism is the idea that the spoken word is secretive by concealing true meanings (Polkinghorne, 2007). In other words, look beyond literal interpretations of dialogue while decoding narrative texts. To achieve data saturation, open-ended and follow-up questions were prepared. Although the level of data saturation is subjective, the researcher should persevere until they believe participants have divulged an exhaustive amount of contextual details to the point of redundancy (Kim, 2016).

Credibility

The task of being a narrative inquiry researcher is an art that has required great listening and fieldwork skills to excavate stories that are both in-depth and valid (Kim, 2016). In a

poststructural nature, layers of stories have been gathered to invoke essential details by fostering relationships of trust with participants (Palmer, 2009). Trust built through ongoing exchanges of emails, phone conversations, and interviews created an environment of openness and honesty. Empowerment is experienced when participants know the value and uniqueness of their stories (Polkinghorne, 2007).

Dependability

Qualitative researchers have filled the void of quantitative numerical data by being thorough and committed during fieldwork and analysis towards the believability of the knowledge claim. A commitment to practices of empathy by imagining being in the story givers position of vulnerability as personal stories has been shared. By going beyond reflection to reflective practices, reflection has occurred twice (Kim, 2016). Additionally, the commitment process has allowed consideration of unknown or unpopular avenues of thought with a unified goal of contributing to humanity (Kim, 2016). Reflection occurred during initial observations and a second time to reflect upon the first reflection.

The collection and interpretation of the evidence should be written clearly and concisely (Polkinghorne, 2007). The goals of being sensitive and in wonderment throughout the research process persisted as a novice researcher. The term *phronesis* has described an enduring quest towards the common good (Kim, 2016). Findings are repeatable by those who diligently record and analyze detailed data, remain open-minded and open-hearted to participants, and by practicing the act of phronesis to offer valid research. Through transparency and close collaboration with each participant, stories were sought after by reporting accurate details that are contextually provocative for the sanctity of the scientific literacy of future leaders. These

practices complemented the existing body of research regarding evolution education to add to the knowledge dedicated to teachers of evolutionary theory.

Expected Findings

The purpose of this qualitative study with a narrative inquiry design was to explore the stories of science teachers teaching evolution in middle schools. Participating teachers taught evolution education within the U.S. for at least a decade. Access was gained by middle school science teachers who allowed their stories to be told. Middle school science teachers are a group of participants rarely found in scholarly research. Having a new demography of participants to interview exposed a broader perspective of stories in evolution education.

The challenge of balancing artistry and academia to rewrite stories has proved thought-provoking and informative (Kim, 2016). In that light, interview questions were written from a storyteller's perspective to gain rich details of the participants' stories to create scholarly research through storytelling. While narrative inquiry research has only become an accepted methodology within the past two decades, this form of research has been used across a multitude of disciplines (Kim, 2016). The success of the narrative inquiry researcher came from stories written for impact and transformation.

Participants were interviewed from rural, urban, and suburban communities using a semistructured process of open-ended questions with follow-up questions needed for story development. Each interview began in a similar fashion using the interview questions listed in Appendix C. However, the direction of the interview using follow-up questions was dependent upon the quality and quantity of responses. Some participants required a few follow-up questions, while other participants required more leading questions to evoke detailed and elaborate responses. Through dedication to the study, an apparent appreciation and respect for

participants, and maintaining a balance of creativity and scholarly exploration, outcomes were sought to support effective change regarding evolution education.

Ethical Issues

The IRB guidelines were adhered to using investigative protocols to conduct research humanely and professionally. IRB protocols stated that confidentiality was critical for participants as an ethical duty to protect identities. Codes were assigned to each participant using P1, P2, for example, without using the real names of participants to protect participant identity. Throughout the study and 3 years beyond the end of the study, all data will be stored on an encrypted file and have been backed up by an encrypted external hard drive. Field notes shall be kept in a locked file for 3 years beyond the end of the research and destroyed at the end of that period.

Ethical practices were applied throughout the research process, with the realization that ethical challenges and issues could have occurred regardless of precautionary measures taken (Kim, 2016). IRB training modules provided protocols on how to conduct safe and ethical research. The Collaborative Institutional Training Initiative (CITI) provided 13 online modules accessed through Concordia University. CITI modules included an ethical framework to consider throughout the research process to include duties to provide minimal risk to participants. Minimal risk is the act of reducing hardships of any participant within a study to promote ethical research. Modules highlighted ways to keep participants' information and identity secure and confidential and to avoid an apparent conflict of interests that would hinder, or skew data collected. Recommendations from CITI modules provided a framework to collect data from participants in a highly ethical manner.

Conflict of Interest Assessment

A conflict of interest has been presented when two or more interests contradict one another (Korenman, 2006). I held no relationship with the participants before the study. Potential conflicts for this study prompted a consideration of preventative strategies to mitigate issues had they risen. The American Educational Research Association (AERA, 2009) presents research standards used by narrative inquirers (Kim, 2016). The following AERA standards to be honored include (AERA, 2009):

1. Human Consent and Access to Information: In accordance with IRB approval, each human consent agreement was honored.
2. Perspectives and Voice: The story of each participant will only be told in a manner of respect and honor.
3. Bias: Potential conflicts between the researcher and participants were made transparent within the research.
5. Evidence and Reasoning: Connections were made to link evidence to each claim resulting in a conclusion based on those relationships.
6. Funding and Sponsorship: Funding or sponsorship was made transparent (p. 484).

It is noteworthy to mention the relationship between the last two AERA standards. Bias has been created when the researcher goes beyond the evidence presented in the data to support a claim based on personal experience (Polkinghorne, 2007). In addition, while AERA standards create a broad framework to have adhered to, *microethics* were considered to include unforeseen incidents that could have created a pause for ethical concerns (Kim, 2016). Microethics considers each participant individually having unique considerations during the data collection and analyzation process.

Researcher's Position

The position of the researcher was unique from other methodologies as a narrative inquirer. Narrative inquirers utilize a sense of phronesis as being a calm and competent researcher who presents research using good judgment and to reveal data optimistically and celebratory in nature (Kim, 2016). This type of researcher has worked incessantly to gain insight into people's lives relative to a topic to simply discover findings in a manner that is scholarly and contextually insightful to assist those interested in evolution education.

Ethical Issues in the Study

Stories compiled from each interview have been gathered with an outlook of exploration and discovery. Narrative inquiry research requires special attention to ethical matters (Clandinin, 2006). By reserving judgment, practicing excellent listening skills, and being cognizant of personal biases, narrative inquiry became an excellent tool for researchers to gain perspectives to share with the educational community (Clandinin, 2007). Participants maintained access to transcripts of each interview and findings of the study to ensure accuracy and confidentiality. The ethical practice of keeping participants' privacy secure was practiced. Data will be kept confidential and accessible to participants and will continue to remain so 3 years of post-research. A mindset free of judgment has been maintained, and agenda-based advocacy to achieve stories high in accuracy and validity are applied.

Ethical competence was required to make appropriate decisions when problem-solving as issues arise. Remaining transparent about the purpose and goals of the study, fostering relationships of trust, and setting clear expectations in a welcoming environment help to reduce ethical compromises (Kim, 2016). Participants were reminded of privacy measures taken to secure conversations about anything that was discussed throughout the inquiry process.

Chapter 3 Summary

The selection of narrative inquiry—framed with the theory of cognitive dissonance—was selected based on alignment with the research question: What are the life stories of middle school science teachers teaching evolution? A narrative inquirer has a higher obligation to achieve scholarly research that other forms of methodology due to the recent development of narrative as a distinctive form of social research (Riessman, 2012). The following conundrum was acknowledged—to present a captivating narrative story while achieving scholarly research with no hidden agenda. By embracing this challenge, a wider audience can be gained if captivation and academic writing are achieved (Kim, 2016). Unlike typical educational studies, narrative enters a world unknown without predicting answers to questions. The goal was to discover numerous and intimate details of the stories of 10 teachers of evolution and to determine the impact evolution has had on their careers.

This chapter has highlighted the methods to be used to learn the life stories of participants. The narrative researcher has utilized a data source of interviews to be recorded, analyzed, and transcribed. The narrative inquiry design included a format to host interviews of stories prompted by teacher stories under the framework of cognitive dissonance. The data from these stories were discovered through careful analysis of recorded transcripts to understand each event and the effect on evolution education. With coding and decoding, patterns were negotiated, and discoveries revealed details about the practice of evolution at the middle school level.

The roles of the creative writer and researcher were pursued to attain a narrative that has potential to hook a broad range of readers. Versatility and perseverance have been vital components to demand extensive writing, researching, rewriting, and more researching until an

exquisite work of art is created (Kim, 2016). Voices of middle school science teachers of evolution education have been amplified who were willing to share specific events.

The following chapter consists of data analysis and findings. In addition, content will include the preparation for the study, a focus of the study, a confidential description of samples, and a research methodology and analysis. Finally, the chapter will contain a discussion of emergent themes using coding with general and significant themes and will conclude with a discussion of findings.

Chapter 4: Data Analysis and Results

Introduction

The purpose of this qualitative study with a narrative inquiry design was to explore the stories of science teachers teaching evolution in middle schools. Research questions are:

RQ1: What are the stories of science teachers teaching evolution in middle schools?

RQ2: What do the stories of middle school science teachers reveal about the practice of teaching evolution?

RQ3: What challenges, if any, have science teachers experienced or perceived while teaching evolution?

RQ4: What do the stories of science teachers reveal about administrative support regarding evolution education?

RQ5: What do the stories of science teachers reveal about support from colleagues regarding evolution education?

Chapter 4 includes participants' demographic data, data collection methods, data analysis procedures, significant findings, and participants' stories.

Description of the Sample

The demographic data gathered from participants were gender, age, race, and the highest degree attained. Table 3 presented the number of years participants taught science, incorporated evolution, and their teaching location. Participant gender was 60% female and 40% male. Participants ranged from 33 to 67 years of age. Fifty percent of participants were retired, and the remaining 50% taught in a public middle school during the interview processes. Ethnicities were 80% of European descent, 10% of African American descent, and 10% of Hispanic origin. The highest degrees attained were 60% with a master's degree, 30% with a bachelor's degree, and

10% held a specialist degree. The participants held a minimum of 10 years' experience teaching science in a public middle school, and all of them integrated evolution into the curriculum.

Table 3 illustrates the demographic information collected from each of the 10 participants. Of the 35 teachers who expressed an interest in the study, 10 participants met the criteria for the study. Forty percent of the participants taught middle school science for 11–20 years, 60% for 21–30 years, 70% for 10–16 years, and 30% for 17–24 years. Participants were selected to gain perspectives from urban, suburban, and rural public-school districts. Within the Pacific Northwest, 50% of participants taught in an urban community, 30% in suburban, and 20% in rural communities.

Table 3

Demographic Information of the Participants

Code	Gender	Age	Race	Education	Experience Teaching Science	Experience Teaching Evolution	Location
P1	F	47	W	B.A.	17	17	Suburban
P2	F	52	H	M.Ed.	29	16	Urban
P3	M	67	W	M.Ed.	30	10	Urban
P4	F	45	W	M.Ed.	18	15	Suburban
P5	M	33	B	B.A.	11	10	Urban
P6	M	47	W	M.Ed.	15	13	Suburban
P7	F	60	W	Ed. S.	25	15	Rural
P8	M	64	W	M.Ed.	24	24	Rural
P9	F	64	W	B.A.	22	22	Urban
P10	F	55	W	M.Ed.	23	10	Urban

Research Methodology and Analysis

This study adopted a qualitative method with a narrative inquiry design. Upon receiving IRB approval on January 6, 2020, participants were sought during an annual science teacher conference. A selection of 10 participants using purposive sampling met data saturation through storytelling. The instrument of one-on-one interviewing afforded data collection, which took place from January 7 to January 20, 2020. Participants were assigned individual codes from P1 to P10, and stories were retold in the order interviews were conducted. Codes were assigned to each participant referred to in the storytelling process to keep all data materials confidential.

As the instrument who collected data, each story required analysis to gain a better understanding of evolution education. Creswell (2014) described a qualitative researcher as the instrument who collects and analyzes data to establish appropriate categories and themes. Semistructured interviews took place in a public library conference room or using a live video feed. Manual coding of data reduces computer error (Kim, 2016). Transcriptions of interviews were organized into four categories and subdivided into general and significant themes. Categories and themes allowed interpretation of events to explore further how participants narrated the teaching of evolution. The choice of manual coding was to ensure that the interpretation of the data materials was present during each step of analyzation. Data were coded by condensing interview questions into categories to identify modes of patterns. Four interview categories and general themes are presented (see Appendix D).

Summary of the Findings

This section includes data summaries from participant stories told during one-on-one interviews. The arrangement of data revealed four categories and 35 general themes. Eight significant themes emerged from the interview data based on participants' stories. Participant

codes protect participant identity and differentiate between responses. Appendix D illustrated the interview categories, general themes, and participants' codes.

General Themes

Four interview categories were created based on the interview questions. These four categories include people and factors that influenced science teaching careers; teaching approaches; challenges of teaching evolution; and support from colleagues and administrators. Generation of 35 from four categories are as follows. The factors that influenced science teaching careers were: (a) authors of scientific books; (b) childhood interest in science; (c) family members; (d) former teachers/ professors; (e) effective science teachers; (f) job security; and (g) college advisor recommendation. Teaching approaches used to teach evolution were: (a) dichotomous keys; (b); vestigial structures; (c) Darwin's Finches; (d) fossil evidence; (e) homologous structures; (f) phylogeny; (g) one species of hominin only, Lucy, *Australopithecus afarensis;* (h) human migration out of Africa; (i) Lucy and several species of Hominins; (j) foramen magnum; and (k) hominin anatomy. The challenges of teaching evolution were: (a) reported colleagues who taught creationism; (b) conflict with religious beliefs among students; (c) students called them demonic names; (d) Jehovah's Witnesses students were less accepting than other students; (e) Jesus Christ of Latter-day Saints students were less accepting than other students; (f) parents requested alternative assignments; (g) parents complained via email or phone call; (h) parents called the principal to complain; (i) had one or more student removed from their team and onto another; (j) taught with colleagues who avoided evolution; (k) students avoided lessons on evolution; (l) lack of labs and real-life examples; and (m) felt pressured to defend teaching methods. The level of support from colleagues and administrators were: (a) referred to collaboration as an invaluable tool; (b) administrators were supportive if clear lines of

communication were in place; (c) had colleagues who said they should not teach evolution; and (d) administrators questioned teaching practices (see Appendix D). Thirty–five general themes fell within one of the four categories created from interview data to pinpoint important patterns of data.

The first category—factors, and people that influenced the field of science teaching—resulted in intrinsic and extrinsic factors of motivation as reported by participants. Intrinsic motivational factors are as follows: authors of scientific books (P1, P2, P3, P4, P5, P8, P9); childhood interest in science (P1, P2, P3, P4, P8, P9, P10); and family members (P1, P2, P4, P5, P8, P9, P10). Extrinsic motivation came from former teachers/ professors (P1, P2, P4, P5, P8, P9); effective science teachers (P1, P2, P9, P10); job security (P1, P4, P10); and college advisor recommendations (P1, P4, P8).

The second category—approaches for teaching evolutionary theory—were: microevolution, macroevolution, and hominins. The teaching approach of microevolution revealed four topics: dichotomous keys (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10); vestigial structures (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10); Darwin's Finches (P1, P2, P3, P4, P7, P9, P10); and fossil evidence (P1, P2, P3, P4, P6, P7, P9). The teaching approach of macroevolution revealed two topics: homologous structures (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10); and phylogeny (P2, P4, P9). Incorporation of hominins (human evolution) revealed five topics: one species of hominin only, Lucy, *Australopithecus afarensis* (P1, P5, P6, P7, P8, P9, P10); human migration out of Africa (P2, P4, P9); Lucy and several species of Hominins (P2, P4, P9); foramen magnum (P2, P3, P4); and hominin anatomy (P2, P3, P4).

The third category—challenges teaching evolution—established three general themes of religious conflict, external challenges, and internal challenges. The challenge of religious conflict

produced the following six topics: conflict with religious beliefs among students (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10); colleagues who taught creationism (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10); parents who requested alternative assignments due to religious conflict (P1, P3, P4, P5, P6, P9, P10); students who called participants demonic names (P5, P8); Jehovah's Witnesses students who were less accepting than other students (P2); and Jesus Christ of Latter-day Saints students who were less accepting than other students (P6). External challenges generated three topics: parents who complained via email or phone call (P1, P4, P5, P6, P9, P10); parents who called the principal to complain (P1, P3, P4, P6, P9, P10); and participants who had one or more student removed from their team and onto another (P1, P4, P10). Internal challenges created four topics: colleagues who avoided evolution (P1, P3, P4, P5, P6, P7, P8, P9, P10); students avoided lessons on evolution (P1, P2, P3, P4, P6, P9, P10); lack of labs and real-life examples (P1, P3, P4, P6, P9, P10); and felt pressured to defend teaching methods (P1, P3, P4, P6, P9, P10).

The fourth category—support from colleagues and administrators—revealed levels of support and a lack of support from both groups. Systems of support offered two topics: referred to collaboration as an invaluable tool (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10); and administrators were supportive if clear lines of communication were in place (P3, P4, P5, P6, P8, P9, P10). Data resulted in two examples of a lack of support: had colleagues who said they should not teach evolution (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10); and administrators questioned teaching practices (P3, P4, P5, P6, P8, P9, P10).

Significant Emergent Themes

Eight significant themes emerged from the 35 general themes. Significant themes—those with a 70% or higher response rate—identified are: intrinsic motivation from science authors, childhood interests, and family members; microevolution as a standard teaching approach to

teach evolution; macroevolution as an uncommon teaching approach for teaching evolution; and hominins as an uncommon teaching approach for teaching evolution. Additionally, the themes of external challenges of religious conflict among students, colleagues, and parents; internal challenges with colleagues and students; support from administrators and colleagues; and the need for support by administrators and colleagues were found to be significant.

Theme 1: Intrinsic motivation from science authors, childhood interests, and family members. The first significant emergent theme was intrinsic motivation from science authors, childhood interests, and family members. Science teacher participants recalled stories from their childhood that shaped educational and professional choices. The impact of experiencing the natural world as a young person resonated with participants to share this knowledge through teaching. P1 stated, "As a child, I loved playing in the woods. I climbed trees, waded in a creek behind my house, and caught minnows. I loved being outdoors." P2 included, "My father was a teacher and then a school administrator, so I grew up around a lot of education conversations in my home. I wanted to find my path and to be independent, but eventually, I was drawn to the field that held my interest as a child." P4 offered, "As a little girl, I loved insects. We took a family trip to camp in the Smokies, and I had never seen fireflies. My aunt bought me a bug catcher, and I was hooked." P4 continued, "I did kill a lot of bugs accidentally, but I kept collecting and observing them with a little magnifying glass. I feel pretty sure that my love for bugs is the start of what led me to teach science." Participants recognized outdoor experiences as impactful enough to determine professional paths. P9 lamented that children today stay indoors with the advancement of technology that has "led to detrimental effects on our species" as referenced to humans. Participants expressed concern for lack of outdoor experiences for students. P4 stated that "When students are outside, they become more active and awake. They

love the fish dissection lab and are amazed to see that fish have little beating hearts and stomachs just like we do!" Participants P4 and P9 expressed the importance of outdoor learning for science education from childhood experiences that led to the field of teaching science.

Professional influences regarding the teaching of science were expressed by participants who credited family members (P1, P2, P4, P5, P8, P9, P10) for inspiration. Participants P4 and P9 attributed their fathers for exposing them to science at an early age. P4 described spending much of her childhood in the woods. "My dad helped me build a fort by wrapping palm fronds around branches without having to use screws. He taught me that nature provided all we needed, which got me asking a lot of big questions about life." P9 told the story of a conversation with her father. "As a preteen, I had bigger questions about the universe, black holes, neutron stars, and rockets. My dad would explain the world as best he could." P9 referred to his honesty as instrumental in shaping her worldviews. P9 stated that "More importantly, my dad was not afraid to tell me when he did not know the answer or that no one knew the answers, yet. This conversation was crucial towards understanding human limitations and inspired me to learn more." P9 said this conversation, "empowered me to find my niche in the world. It drove me to discovery."

Authors who published books of biological evolutionary interest served as an additional influence on participants to enter the field of science. The confidence participants held on these authors were evident as they fluidly spoke direct quotes of scientific works from authors (P1, P2, P3, P4, P5, P8, P9). P2 reflected on books by Richard Dawkins to describe the work as "a living exchange of evolutionary concepts that students can relate to more so than Charles Darwin, who lived in the 1800s." Additionally, P2 reflected that Dawkins, "insightfully encouraged the importance of teaching the art of how to think, how to disagree, and the strength of questioning

with an informed mind.” P2 expressed the importance of teaching problem-solving skills and the limitations of science. P2 concluded by describing, “Science is humanity's best way of figuring stuff out. Science has given us vaccinations, artificial hearts, televisions, internal combustion engines, and rocket ships to the moon."

P6 cited Dr. Neil Shubin as the author who strengthened the understanding of phylogeny—the branch of biology that represents evolutionary relationships among species. Dr. Shubin wrote a book titled *Your Inner Fish,* which compared the human skeletal system to that of fish, amphibians, reptiles, birds, and other mammals according to P6. The book provided evidence for P6 to use in class in which students could “observe the striking similarities of non-human anatomy compared to other animals known as homologous structures.” P6 also utilized online resources created by Dr. Shubin to provide evidence of phylogenetic charts. Such evidence was used by P4, P5, and P6 to “describe the one, two, many bone patterns found in human arms, alligator legs, and even the wings of a bird.” P4 offered the following diagram for evidence.

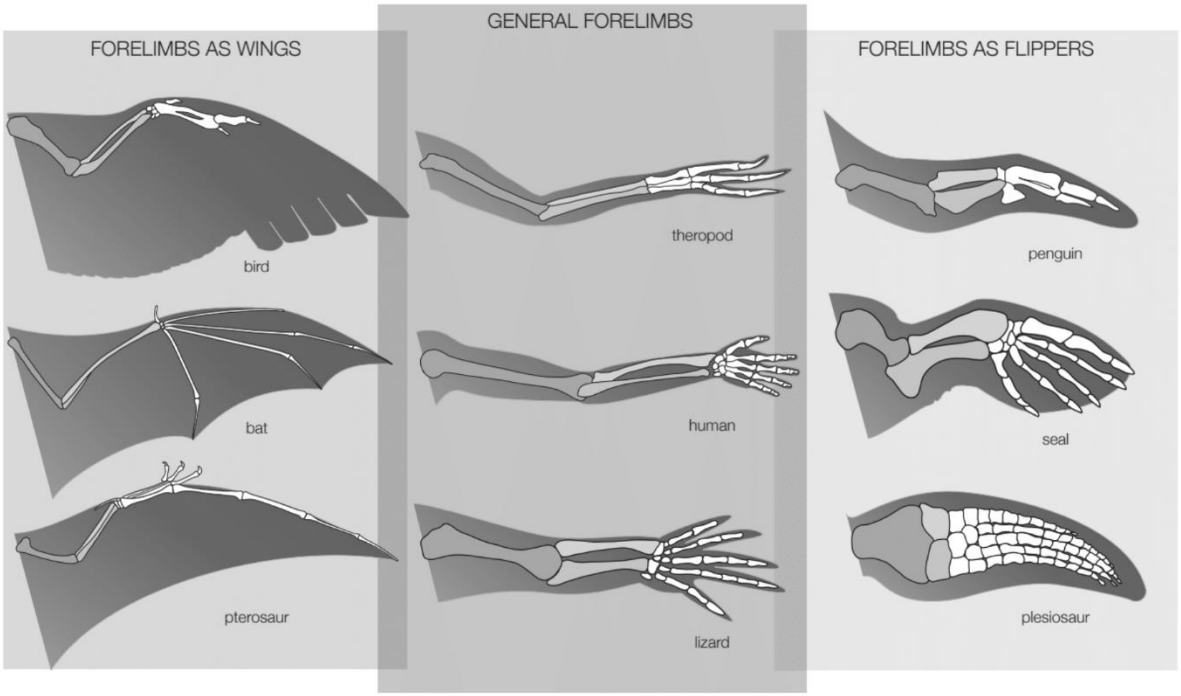

Figure 2. Homologous structures. Reprinted from "Your Inner Fish," by N. Shubin, Copyright 2014 by Vintage Books. Reproduced with permission from Monoyios.

Theme 2: Microevolution is a common teaching approach to teach evolution. The second emergent theme was microevolution as a teaching approach to teaching evolution. Participants taught microevolution using dichotomous keys, vestigial structures, Darwin's Finches, and fossil evidence. Dichotomous keys (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10) was a teaching approach used for students to classify organisms based on physical evidence. P9 described gathering materials "of just about anything to classify and create dichotomous keys. Observing likenesses and differences in organic things is part of the puzzle to allow these young humans to start to make connections to diversity and unity." The topic of vestigial structures (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10) provided evidence of anatomical features such as wisdom teeth that human ancestors needed, which cause problems for present-day humans. All participants referred to wisdom teeth, the appendix, and tonsils as vestigial structures. P8 used

the remnants of hind legs on present-day whales as an example of species losing anatomy based on habitat. “I had a porpoise skeleton hanging above my desk and pointed to vestigial bones in the area where hind legs of its ancestral form did sport walking legs.” Students wanted to know more about evolution after this lesson, according to P8. Participants used fossil evidence (P1, P2, P3, P4, P6, P7, P9) and Darwin's Finches (P1, P2, P3, P4, P7, P9, P10) as instructional approaches to teaching evolution. P3 described his collection of fossils, “I had several glass cases of fossilized plants, animals, and even animal dung. The kids loved passing these around the room, as we often did. A lot of fellow teachers said that my classroom looked like a museum.”

P7 also reported the use of Darwin's Finches, “I teach the story of the finches with a bird beak lab where students use tools such as nutcrackers and chopsticks to replicate the beaks of birds and simulate them in nature.” P7 explained that students performed better on assessments with the use of labs than without. P2 used flea medication to illustrate that, “Students understand random genetic mutations and that some mutations are beneficial to fleas, which resulted in a resistance to the flea medicine. These mutations were heritable and spread across the population.” P9 stated, “before evolution, we discussed mutations and how traits pass through generations and fossils were found and analyzed within the layers of the earth. These topics laid a necessary foundation for the evidence for evolution.”

Theme 3: Macroevolution is an uncommon teaching approach for teaching evolution. The third emergent theme identified was the teaching of macroevolution—the relationship between various species of organisms, known as phylogeny. Homologous structures (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10) was the only significant theme used to teach macroevolution (see Figure 2). P5 used homologous structures to represent the phylogeny of organisms, “I teach with color-coded bones in a batwing, a cat’s arm, and a human’s arm, and a

diagram of embryos of varied species. The study of homologous structures represents the undeniable similarities that various species have."

Theme 4: Hominins as an uncommon teaching approach for teaching evolution. The fourth emergent theme was the teaching of hominins—human ancestors—taught during evolution. Participants taught the extinct species of human ancestors using one species of hominin, Lucy, *Australopithecus afarensis* (P1, P5, P6, P7, P8, P9, P10). P7 stated, "I do not teach human evolution, and I am just happy we're able to finally address evolution. Teaching evolution is not as tricky as it once was." P8 described the inclusion of human evolution as "I did not get into it other than answering related questions. It was part of the curriculum, but it was not dealt with." P8 explained that there was not enough time to include every concept. He stated, "I was more interested in getting them outside. I would get them out to the bay to do carrying capacity. I don't want to rock the boat. I would tell them the common chromosome with chimpanzees." P6 discussed having a lack of time to include every standard and stated, "We do not talk much about human evolution except a bit about Lucy, who is over three million years old."

P9 noted that *human* evolution was a "natural outgrowth of teaching evolution." By incorporating human evolution, students made personal connections with the tree of life, according to P9. P9 indicated, "It was powerful for students to understand the common ancestors of hominins and that we did not evolve directly from monkeys. Human common ancestors were neither modern monkey nor modern human. The evolutionary paths of humans split over millions of years." P9 concluded that the incorporation of *human* evolution allowed students to understand that all organisms are related, including humans.

Theme 5: External challenge of religious conflict among students, colleagues, and parents. The fifth emergent theme was a religious conflict during exchanges with students, colleagues, and parents regarding the teaching of evolution. Religious beliefs among students prompted conflict for participants (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10). P6 said that, "avoidance was not an option for students who deserved answers to their questions." To develop open forums on religion, P6 offered viewpoints and allowed students to "discuss worldviews and blend new strategies so students could analyze how religious ideologies vary." P3 avoided the conflict and informed students that religious conversations were "inappropriate in a science classroom."

All participants had colleagues who taught creationism (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10). P3 and P4 worked with teachers who taught creationism. P4 taught with several science teachers throughout her career who, "did not accept evolution as valid and reliable science." P4 told the story of a fellow teacher, "A few years before retirement, I taught the son of a high school biology teacher who was adored by the community. He was a bone cancer survivor and openly taught creationism in his public high school biology course." P3 told a similar story of two teachers he worked with who "taught that evolution was *just a theory* and discussed Christianity. Everyone knew they taught religious ideologies, but I think they are still teaching the same way to this day without repercussions." The challenges these participants reported were with colleagues as well as students.

Parents requested alternative assignments due to religious conflict (P1, P3, P4, P5, P6, P9, P10). P3 reported families of Greek students taking family vacations during the unit on evolution. He said he would come to school to find that, "several students would be absent on each consecutive day during the unit on evolution. All assignments and activities were available

online, and a few of these students made up their lessons, but most did not." Participants exchanged in religious conversations with students as well as navigating the topic with colleagues.

Theme 6: Internal challenges with colleagues and students. The sixth emergent theme revealed reports of participants who taught with colleagues who avoided evolution (P1, P3, P4, P5, P6, P7, P8, P9, P10), and students avoided lessons on evolution (P1, P2, P3, P4, P6, P9, P10). Participants told the stories of science teachers who taught evolution incorrectly. P3 reported two colleagues who were "well known for their devotion to religion and taught students that evolution was just a theory." P3 said that teaching the significant difference between philosophical theory and scientific theory was pivotal in starting a unit on evolution. Religious conflict was storied by P3 to include students and colleagues. Conflict with students "produced meaningful discussions" while participants avoided disputes with colleagues.

Students avoided lessons on evolution according to several participants (P1, P2, P3, P4, P6, P9, P10). P2 told the story of a student who would "turn and face his chair towards the wall during the entire unit on evolution." Middle school students, "bring their faiths from home and should not be penalized for following indoctrination they have been taught within their families," according to P4. Student avoidance of lessons on evolution created additional work for teachers who were responsible for finding alternative assignments to make up for missed work. P4 reported, "I had 145 students to prep labs for, grade papers, and keep focused. When students avoided lessons on evolution, I felt an obligation to offer them a new lesson to keep them busy." Participants reported the conflict of religion from students who brought predispositions about evolution before learning how the theory.

Theme 7: Support from administrators and colleagues. The seventh emergent theme was the support offered by administrators and colleagues regarding the teaching of evolution in a middle school setting. Participants told the stories of how they received support as they referred to collaboration as an invaluable tool (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10). P1 reported that her best teaching was during collaboration with a fellow science teacher who "worked together to develop units and lessons to help with student understanding. We created a hominin project where students chose one hominin and created a presentation on inferred attributes." P9 attributed collaboration with another science teacher to navigate the teaching of evolution. The teacher whom P9 collaborated with, "constantly pushed forward to challenge the teaching comfort zone and continually edit curriculum each year to make every activity more effective. We served to balance our extremes. I have always been grateful for these collaborations." Collaborative efforts were reported as supportive and unsupportive towards the teaching of evolution.

Theme 8: A lack of support by administrators and colleagues. Alternatively, participants had colleagues who told them they should avoid teaching evolution (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10). P5 told the story of discussing evolution with his team of teachers and reported that the math teacher was "really religious." When P5 discussed evolution, the math teacher said, "she said that God created the world in 7 days and that students should not hear otherwise. We had an awkward conversation, and I realized that I had to censor my topics of discussion." P5 said he was now "cognizant that people feel strongly about their beliefs, and I should consider how to approach sensitive subjects." Participants offered stories with colleagues and stories of support given by administrators regarding the teaching of evolution.

Participants worked for administrators who supported evolutionary teaching practices (P2, P4, P5, P6, P7, P8, P9, P10). P8 reported that he had "almost no issues teaching evolution." A parent called to complain about the teaching practices of P8, which prompted the principal to question his teaching methods. Once P8 explained how he taught evolution, his principal was "definitely supportive, and after I reviewed my methods and treatment of those students who questioned the theory." P2 felt supported by administrators who, "do not bother teachers when they know they are strong in their content area. They support us by giving us room to do our jobs without interruptions." P9 told the story of administrators who had a "poor understanding of evolutionary theory." Community members organized to remove evolution from the curriculum, which required P9 and other science teachers to organize and educate administrators.

Once P9 and fellow teachers presented to administration and commented, "Overall, our administration was supportive. Even two of our board member whose children were in the class, and who were themselves very conservative and religious, supported our science-only teaching of this topic." P9 admitted, "It was a little disturbing; however, that without a united science department willing to force the issue and have an open discourse, the situation might have been very different." Participants reported stories of support from administrators once they navigated the principles of evolution and teaching methods used in the classroom.

Presentation of the Data and Results

Participants' Stories

P1's story. P1 held a bachelor's degree and taught middle grades science for 17 years in a suburban area in the Pacific Northwest. P1 entered the field of science after a college counselor presented teaching as an option based on credits they had already earned. P1 was urgent to get a job after graduation to purchase a home and start a family. P1 was inspired to teach by a fellow

science teacher. P1 narrated that, “students enjoyed learning, and there was mutual respect between teacher and students.” The excitement of teaching science was evident as P1 described the story of Mr. K leading a lab on the muscles of the human body. Evolution was taught by P1 using a textbook, state and national standards, and web resources to search for existing units on evolution. The unit on evolution included microevolution, macroevolution, and fossils. Microevolution is taught using examples of Darwin's Finches and the domestication of dog breeds. Macroevolution was taught by referencing geologic time. During a unit on fossils, P1 narrated, “Students are very interested to learn about how life has changed. The unit on fossils rarely causes an uproar regarding evolution, so it is a safe unit to teach."

P1 reported that human evolution was “the touchiest subject” to broach in middle school science because “at least one or two students in each class blurted out that they did not come from a monkey.” P1 taught human evolution within a one to two-hour class period using the story of *Australopithecus afarensis*, known as Lucy. P1 narrated, “Human evolution should be included in preservice teaching programs. It is left out because the topic always arouses argumentative responses from students of religious families.” The story of P1 revealed the need for teacher training and minimal time spent on human evolution to avoid the controversy.

P1 worked with a science teacher who “referred to evolution as something that could be accepted or not accepted.” P1 reported, “the controversy surrounding evolution is not just among community members but amid the worldviews of science teachers. To tell students, as a science teacher, that a theory is not plausible is a blatant misrepresentation of science.” P1 described religious conflict from students, parents, and colleagues as a significant challenge of teaching evolution. P1 reported that a fellow teacher said in front of students, “I do not know about you, but I did not come from no monkey.” P1 concluded by saying that, “I began to question my job

security each time I began a unit on evolution." The challenge of religious controversy involved students during the unit on evolution, while difficulties with colleagues transpired throughout the school year, according to P1.

***P2's story*.** P2 held a master's degree and taught middle grades science for 29 years in a rural part of the Pacific Northwest. P2 was inspired to teach science by her father and "immersion in science throughout her childhood." P2 cited Richard Dawkins as most influential for the aiding the teaching of evolution by narrating, "I have read all of Richard Dawkins' books on biology and evolution, and we were fortunate enough to meet at a conference for science educators. Dawkins offered to come to speak to the science teachers in the county." Forward thinkers such as Dawkins remind us why predecessors orchestrated a Separation of Church and State, according to P2.

P2 taught genetics before evolution and sought examples students could identify with such as, "random genetic mutations in flea populations. Some of these mutations were beneficial to the fleas, making them resistant to flea medication." P2 found that lessons in which students could relate to were more effective than those less visible. Vestigial structures—ineffective anatomies—such as wisdom teeth and the appendix are apt examples for teaching human evolution according to P2. "Vestigial structures are anatomy our ancestors needed that we no longer need," stated P2. Skulls of different primate and hominid species were presented by P2 "to learn the evolution of modern humans: the way the frontal cortex expanded, and the dental arch decreased in size as a result of various selective pressures."

Support from colleagues and administrators varied. Referring to support from colleagues, P9 explained, "teachers need support from each other in all areas of the curriculum, not just evolution. Support systems are valuable, and I try to offer support to others whenever possible."

P2 referred to religious conflict with students who "were not sure they had permission to believe in evolution." P2 recalled teaching Jehovah's Witnesses who would "tell me repeatedly that they did not believe any of this stuff." P2 further explained, "I did not ask students what religion they were, but when a student mentioned they were Catholic," the response given was, "The Catholic Church has publicly announced an acceptance of the theory of evolution, and this is true for the vast majority of denominations." P2 described a pervasiveness of misconceptions that stemmed from dogma and concluded, "A child raised in a faith that accepts evolution still dismisses ideas well before exposure to the science." P2 asserted with dignity, "teachers must learn how to overcome challenges to incorporate evolution. Biology should always be taught through the lens of evolution." P2 spoke of religious conflict among students as an ongoing challenge overcame with practical teaching approaches and sensitivity towards diverse worldviews.

***P3's story*.** P3 held a bachelor's degree in biology and taught middle grades science in the suburbs in the Pacific Northwest for three decades. The parents of P3—a college professor and research chemist—served as an encouragement to enter the field of teaching science. P3 credited inspiration from Jerry A. Coyne, who authored books on evolution. The knowledge P3 gained from Coyne clarified evolutionary principles. P3 narrated, "books by Coyne taught me what I should have learned in high school and college about evolution."

P3 indicated the importance of teaching students' real-life examples. "Coyne offered examples of evolution such as the mosquitoes in England that followed people into the subways during WWII air raids," according to P3. Along with evolutionary examples, P3 learned from Coyne the "intricacies of the human brain—not afforded to any other species—allows us to understand the universe which we should not take for granted."

Once a student asked P3 if they "believed in angels." Initially, P3 just told the student, "no" but then thought the student deserved a better answer from a science teacher. P3 responded to the student, "It is anatomically impossible for a human body to remain in flight with a wingspan even as wide as 15-feet." P3 gave an example, "The world's largest wingspan belongs to the wandering albatross, who has a 12-foot wingspan to hold the weight of a bird just 16 pounds." P3 described the nature of the bird's bones being hollow and the structural design of their chest cavity. P3 concluded that most students agreed that this example sounded reasonable. P3 realized that "evolution must be included for students to understand and appreciate the geologic time scale." Units on evolution were taught by first providing a clear definition of the word *theory*. P3 taught evolution visually with microevolution, macroevolution, and fossils.

P3 taught human evolution by describing scientific evidence of hominins. Hominins transitioned from four legs to walking predominately upright on two legs known as bipedalism. P3 showed brain size, brow ridge, teeth, and vestigial structures such as wisdom teeth. The teaching approaches of microevolution, macroevolution, was addressed by P3. Administrators support teachers with substantial pedagogical content knowledge, according to P3. When students did not attend classes during the unit on evolution, "Administrators did not question this behavior to my knowledge." Administrators supported the teaching of evolution but did not actively pursue those who chose to avoid the teaching of evolution.

P4's story. P4 held a master's degree in biology and taught middle grades science for 18 years in the southwest suburbs of Portland in a farming community. P4 referred to family camping trips as inspirational for teaching science. P4 voiced that students should experience nature more often. P4 credited Dr. Neil Shubin as the most influential author and referenced a book titled *Your Inner Fish*, which provided examples of homologous and vestigial structures.

Other influences were childhood events of P4 in which they performed experiments in nature, “without even realizing, I was acting like a scientist.” P4 referred to authors and childhood experiences to support teaching strategies and approaches.

P4 prepared for teaching evolution by pairing textbook modules with state standards to create an outline. The phylogeny of the animal kingdom allowed P4 to teach macroevolution. P4 reported the use of websites and collaboration with “like-minded" science teachers to prepare for teaching evolution. Biointeractive.org was referenced by P4 to illustrate the microevolutionary example of Rock Pocket mice and Anole lizards, in which P4 brought a few lizards for students to observe and expressed that, “tactile learning brought excitement to science education.” P4 taught an online simulation of Peppered Moths to teach macroevolution and microevolution. “Using plants to teach evolution is less controversial than teaching human evolution," explained P4.” Evolution was taught by P4 using “the phrase natural selection—the mechanism used to explain evolution," to be “sensitive to students from religious homes made up much of the community.” Evolution was the last standard in the state curriculum, and teachers reported they “ran out of time to teach evolution," according to P4. P4, “skimmed" over evolution because it was, “just was not worth the risk.” P4 described being in a content area where “evolution was unaccepted" but conceded that, “the idea of offending anyone made me both angry and scared. I just wanted to teach the curriculum.” P4 conveyed a desire to be an effective teacher for the benefit of students and administrators, without causing adding to the controversy.

Administrative support was narrated by P4, who compared creationism to evolution for students to have constructive conversations. P4 confided feeling, “very nervous to defend teaching methods," but that the dialogue felt, “mostly supportive after I explained my teaching approach.” While administrative support was mentioned as supportive, P4 described feeling

cautious about teaching evolution once teaching practices where questioned. P4 cited collaboration with colleagues as supportive and challenging in terms of teaching evolution. Working with teachers knowledgeable on evolution was empowering and capable of overcoming barriers, according to P4. The science teachers who spoke of evolution as *just* a theory—a common inaccuracy—often spoke of religious beliefs reported P4. P4 witnessed evolution taught incorrectly, reduced content, and the practice of avoidance from colleagues.

P4 did not want to be "judged for teaching what was required to teach." P4 referred to "multiple misconceptions and religious conflicts among colleagues that it affected my teaching practices." P4 admitted they did not spend as much time on evolution as they should have but did cover all standards within state curricular guidelines. However, P4 concluded feeling prideful as a practical science teacher attributed to high interest among students. The importance of reducing the controversy was evident for teaching evolution, as described by P4.

P5's story. P5 held a bachelor's degree in middle grades science and taught middle school for 11 years. P5 incorporated evolution for nine years and expressed feeling thankful and excited to explain, "such an interesting and unique subject as life science." P5 found inspiration within high-tech aspects of science but entered the field of life science due to a job opening. P5 reported influence from a former Professor B. "I learned many cross-cutting strategies that I continue to use in my classroom. Professor B continues to be immensely encouraging and supportive of a teaching career." When P5 began a unit on evolution, they prepared students by letting them know, "You do not have to accept the theory of evolution, but you do have to understand the scientific perspective." P5 informed students, "I am only exposing you to the information studied based on scientific research, and you have a choice of whether to accept it into your belief system or not." The teaching of evolution began with a disclaimer from P5 to ensure that

students would feel comfortable learning content that may have conflicted with religious beliefs or worldviews. During the unit on evolution, P5 organized a professor from a local college to present a lesson on human evolution. The professor gave a lesson on *Australopithecus afarensis*—affectionately known as Lucy—and showed students a documentary. P5 taught homologous and vestigial structures. P5 expressed that students were fully engaged in lessons about extinct human ancestors since "it directly related to their past."

P5 narrated a story of an exchange with a math teacher who was a young-earth creationist. The math teacher told P5 that evolution was false, and that Earth was created in seven days by a supernatural being. From this conflict, P5 sought support from fellow science teachers who suggested to "remain objective and to stick to the curriculum." P5 concluded that "I need to be cognizant that people feel strongly about their beliefs and thoughts about how you approach sensitive subjects."

P5 anticipated having issues with parents while teaching evolution. While no confrontations with parents occurred, they attributed this to "teaching evolution with a prominent level of sensitivity towards beliefs of any kind." P5 did have "a few students spreading rumors that they were an atheist because they told students that they did not personally assign to any specific religion." P5 was very disheartened by this and would not discuss religion at all with students in the future. Challenges reported by P5 included religious conflict with teachers and students. Challenges met with strategies for avoiding conflict included: a disclaimer for students, reduced conversation with colleagues, and avoidance of religious discussions with students and colleagues about evolution.

P6's story. P6 held a master's degree in microbiology and was unable to find a job in this specific field. P6 did secure a job teaching middle school science and taught science for 15 years.

Inspiration for teaching came from the participants' mother who, "instilled a love of nature and art to appreciate the natural world." P6 noted the lack of effective teachers and. "wanted to share the excitement of science with students." P6 credited job availability and a parent as factors that led to the teaching of science.

P6 referred to parent meetings regarding evolution as the most memorable moments. P6 exclaimed that "Parents came in hot and angry, but when they would leave, maybe not agreeing with them, they were diffused and had a newer level of understanding of evolutionary theory." P6 said some favorite moments teaching evolution involved, "students who admitted that they emphatically did not *believe* in evolution at the beginning of the unit, but by the end of the unit, they had a hard time finding anything specific to say they disagreed with." P6 concluded, "They would still say they disagree with evolution; they would just not be able to explain why." Communication and clarification were key for P6 to navigate through the controversy.

Regarding human evolution, P6 narrated, "We do not talk much about human evolution except a bit about Lucy, who is over 3 million years old. Human evolution gets everyone upset and is not on state assessments." P6 taught evolution by following state standards and incorporated macroevolution and microevolution. Avoidance of human evolution occurred to maintain religious sensitivity for students and parents.

P6 cited collaboration with colleagues as "highly effective among competent teachers. We worked through common misconceptions to transform students and parents who were combative." P6 credited collaboration as, "powerful during the teaching of evolution since students from different teams would discuss what they were doing in their classrooms and reduced the likelihood of one teacher being attacked for their teaching practices." Collaboration

among teachers in the same field increased the confidence of teaching evolution, according to P6.

P6 reported challenges of teaching evolution by narrating, “Parents notoriously pushed back during the lessons on evolution and administrators tended to mediate demanding situations.” P6 required alternative lessons from administrators for parents of students whose religious beliefs conflicted with religion. P6 maintained that “the majority of parents supported solid science, but it is parents who complain that make concerns known which affected my ability to convey these ideas to students who deserved a comprehensive education.” P6 concluded that many administrators and parents were supportive, although the few parents who complained about the religious conflict were more vocal than those in support of evolution.

P7’s story. P7 held a specialist’s degree and taught middle school science for 38 years before retiring in the suburbs in the Pacific Northwest. P7 entered the field of science due to the need for science teachers and credited a colleague and principal among those most inspiring. The colleague was territorial yet exemplified effective teaching strategies that P7 observed and embodied.

P7 exclaimed that during the first 15 years of teaching evolution, “it was not even part of the state curriculum.” P7 narrated that colleagues did not use the word *evolution* to teach evolution and instead used the phrase *natural selection* to avoid religious conflicts. P7 taught the six kingdoms of life and the human body until evolution became part of the state curriculum. P7 reported teaching practices: “There were plenty of lessons that included looking at adaptations and how they ensure survival, so they had been teaching evolution all along without calling it that.” P7 concluded, “it does not matter what you call it if students are getting the information.”

By referring to evolution as natural selection, P7 was able to camouflage evolution into the curriculum and reduce religious tension to teach without controversy effectively.

P7 narrated the teaching of evolution, "I began evolution by telling students that evolution does not challenge religious beliefs and that we are going to learn about it together." P7 told students that "no one could force them to believe anything and that they held the freedom to make up their minds as an independent thinker." P7 taught the story of Charles Darwin and his 5-year voyage around South America, where they landed on the Galapagos Islands more than 200 years ago. P7 continued, "We discussed the method of dating rocks and fossils and moved into deep geologic time to wrap up the unit on evolution." P7 taught stories of the father of evolution, Charles Darwin, and incorporated fossils and geologic time to teach evolution. P7 reported avoiding the topic of *human* evolution and explained that "I was just happy I could finally address evolution since they were now in my state standards." P7 stated never having a parent or student complaint about evolution as "other teachers had who incorporated human evolution." They went on to say that teaching evolution was "not as tricky as it used to be." P7 said, "I taught the unit carefully and did not act forcefully and rarely used the word evolution. I taught evolution without reservation." P7 credited the lack of controversy over evolution to teaching evolution carefully and with consideration to avoid *human* evolution. P7 reported that administrators supported teaching practices and were aware of "living in a religious area. I knew that using a little common sense went a long way with teaching evolution."

Evolution taught with sensitivity towards various worldviews transpired by P7, who questioned, "maybe veteran high school biology teachers have more experiences with teaching evolution effectively." P7 cited administrators as being supportive of teaching evolution due to the awareness of religious beliefs. P7 reported no challenges for teaching evolution.

P8's story. P8 held a master's in biology and was a retired science teacher from a coastal area of the Pacific Northwest who taught for 24 years. During all 24 years, he taught middle grades life science and incorporated evolution into his lessons. P8 acknowledged an interest in the natural world, including birdwatching and beekeeping, gardening, and reading books based on scientific interests as reasons for entering the field of science. P8 credited family and friends who encouraged the teaching of science.

P8 described their purpose as a science teacher was to lay the foundation for students to make their discoveries. P8 narrated that, "students accepted evolution, or they did not." P8 explained that "the job of a science teacher was to provide students with basic key concepts with some examples and some hands-on things using dichotomous keys." During dichotomous keys, P8 piled items on a display table for students to classify using a key and providing reasoning to support their decisions. P8 summarized lessons: "perhaps students saw something that stuck and made some connections on their own to understand the concepts of natural selection."

P8 concluded, "I never directly explained to students how evolution worked, but I explained it through the process of natural selection, and students were able to reach accurate conclusions." P8 incorporated literature to teach evolution: "by using literature and science news. Students were required to give an article review, which kept students abreast of current events as they related to science. Every day students had to do a journal entry regarding the topic and review." P8 taught evolution indirectly, allowing students to discover personal meaning using hands-on labs and by referring to evolution as *natural selection*.

P8 narrated that "human evolution was part of the curriculum, but they did not teach it." Referring to human evolution, P8 said: "I did not want to rock the boat." P8 taught students about similar chromosomes among chimpanzees and humans and noted that "human evolution

was included in my college courses, but it was not at the forefront of teacher training." P8 said that teachers were always pressed for time. P8 expressed being more interested in "getting students outside to experience biology anytime we could." P8 ended by saying, "I would get students out to the bay to do carrying capacity which got students outside of the classroom and allowed them to experience life as it was happening." With limited time, P8 prioritized teaching approaches by exposing students to nature with outdoor labs and real-life examples of evolution.

P8 reported that administrators and colleagues served as ongoing support systems for teaching evolution. Colleagues served to enhance the collection of lessons and teaching materials. Administrators supported teachers who "were strong in their content area and did not cause conflict among students and parents." P8 reported no challenges while teaching evolution and expressed empowerment by colleagues and administrators.

***P9's story*.** P9 held a bachelor's degree and taught public school for 32 years in the suburbs in a small Pacific Northwest community. P9 included evolution in 22 years while teaching middle school science. P9 credited his father for "providing childhood experiences with science from stargazing to admitting that scientists do not have all the answers to the big questions in life." Equipped with the power that unique discoveries remained, P9 was inspired to enter the field of science education.

P9 described feeling empowered by inspiring and encouraging curiosity among science students. The unit on evolutionary theory allowed, "the opportunity for students to think deeply to the formation of the earth and the origins of life itself." P9 stated that students became "fascinated by the idea that life did not appear on earth for most of the earth's history and that the first cells formed in the oceans, although the how they formed remains a mystery." From there, P9 taught students that everything else evolved over eons and eons of time. P9 described the

most exciting aspects of teaching science to middle school students as “addressing misconceptions and providing students with tools to be analytical about any information to gain exposure both within and outside the classroom.” Misconceptions included the definition of the word *theory* as it relates to science and geologic time. Once students were made aware of the minuscule period humans have inhabited earth, P9 explained they had a better appreciation for the diversity of life. Overcoming misconceptions and geologic time were central to the teaching of evolution for P9.

P9 described the most considerable advantage of teaching evolution was “the epiphany students gained from the understanding that all living things are related and interconnected not only to each other but to their non-living environments.” P9 explained that “as the earth has changed and continues to change, so too have life and landscapes upon it.” Of all the topics science teachers are required to teach, P9 felt an ongoing need to “justify instructional strategies during the teaching of evolution.” Conveying a sense of interconnectivity of students to their natural world was another critical component for P9 in the teaching of evolution.

P9 taught human evolution as “a natural outgrowth of evolution." P9 discussed ancient hominid relatives, tree diagrams of how other organisms evolved, and informed students, “they did not evolve directly from monkeys.” P9 explained that evolutionary paths split many species that went extinct that link humans to monkeys. Homologous structures illustrate comparative anatomy among humans compared to other species extinct and living. Relative DNA sequences, interactive labs, and fossil records allowed P9 to interweave human evolution throughout the unit on evolution. P9 narrated, “By interweaving human information with the other organisms we discussed, students came to see humans as just another organism that had evolved.” P9 taught microevolution, changes with the human body, and the phylogeny of macroevolution.

The challenges of teaching evolution came from religious conflict from students and parents. After several parent complaints, P9 realized that "my administrators thought that evolution was *just* a theory." P9 organized with the science department and, "presented a unified front in preparing our administration by educating personnel on the standards of evolution. It was a revelation to realize the expanse of misconceptions about evolution among our advisors." P9 was disheartened to "surmise that intelligent and well-educated people continually deny facts and blur the boundaries of science and religion regardless of the impact on the survival of humankind." P9 had to collaborate and define a structure for teaching that "made it palatable for students and adults to be stimulated into deep thinking while being sensitive to those in opposition to the theory." P9 surmised that teachers must communicate thoroughly with other science teachers and administrators to maintain support for evolution education.

P10's story. P10 held a master's degree in education and taught middle school science for 23 years in the southern Pacific Northwest. P10 taught in an urban community described as "ultra-religious and not accepting of the change." P10 was inspired to teach science by a former high school biology teacher who taught anatomy with cat dissections. "I was upset at first, but the teacher said participation was completely voluntary and explained how dissections held the potential to save thousands from current and future medical students." P10 had a transformational experience with a former science teacher whose empathy held a lasting effect on the participant to teach science. P10 taught evolution beginning with macroevolution to represent how life is related using the following phylogeny diagram.

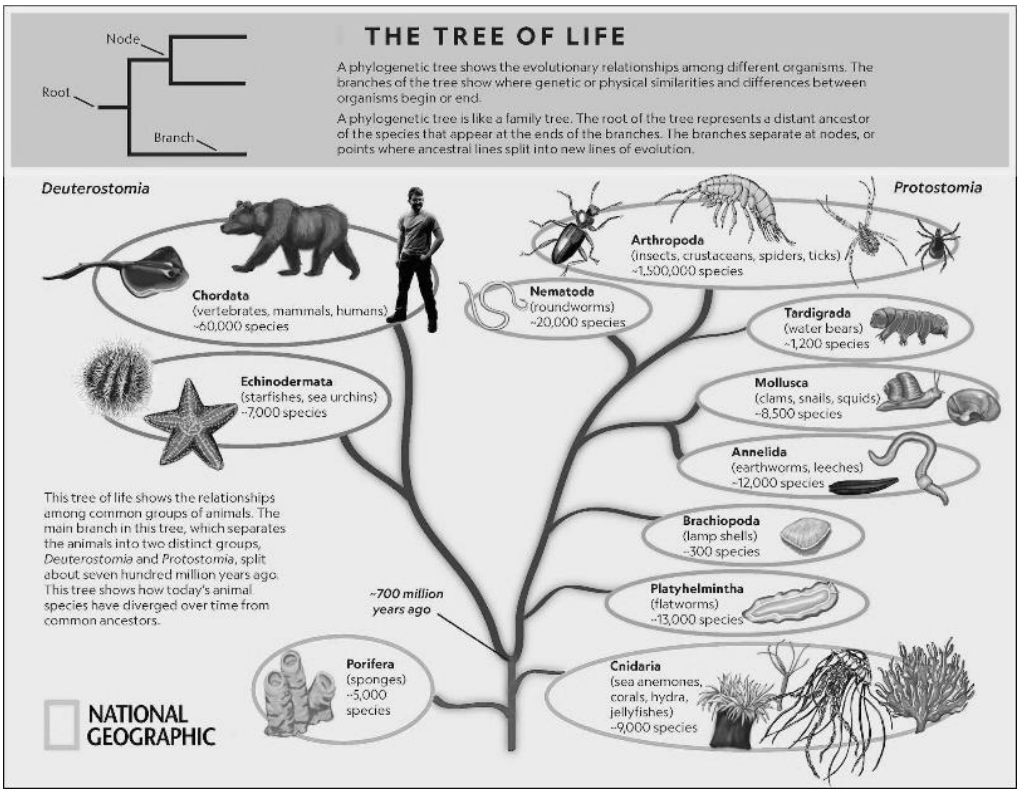

Figure 3. Phylogenetic tree. Reprinted in accordance with Fair Use copyright law. Copyright 2019.

P10 continued this lesson with five classes of vertebrates and explained how all forms of life transitioned from bacteria to animals through evolutionary mechanisms. P10 explained, "Science and religion are different. There is no reason to discount the Bible or offend personal beliefs over the curriculum. However, students need exposure to the geological time scale to understand the gradual processes of life on earth." P10 taught examples of microevolution to include the stories of Peppered Moths Post-Industrial Revolution.

Regarding human evolution, P10 narrated, "The primary challenge in the faith/science artificial divide remains controversial. People think they are different from the animal kingdom." Humans are classified as animals, although there is a common misconception that humans are "somehow disconnected from the animal kingdom," according to P10. I did not talk much about

human evolution. I did not want to fuel unnecessary turmoil." P10 discussed placing value on personal beliefs and exclaimed that we should never force students to "defend their faith" in a science classroom. P10 taught evolution with examples of macroevolution and microevolution and did not teach human evolution.

In terms of support from colleagues, P10 said, "I often felt like a lone ship which was always learning about the content area so I could have enough facts to support and defend my teaching practices." P10 explained that "my colleagues knew little about evolution and made several comments about religion that blatantly increased while I was teaching evolution." At one point in their career, P10 began, "eating lunch with my students because the table of teachers was always making religious comments and even made negative comments about teaching evolution." P10 referred to collaboration with colleagues as beneficial. "I worked with one science teacher who had a degree in biology and knew a lot about evolution. They showed how to teach evolution effectively." P10 reported support from some colleagues and religious conflict with others.

The challenges for P10 were religious conflict with colleagues and a personal journey to teach evolution. P10 explained, "I am a person of faith, and choose to embrace faith and science as two different lenses to view life." P10 narrated a concern for evolution taught at the end of the school year. "It seems like evolution is pushed to the end of the curriculum when teachers are preparing to review students for state assessments." P10 explained that they did not spend as much time on evolution as they did the other units and, "I always wondered why we cram it at the end of the year, but everyone knows the reason is religious beliefs." P10 stated that evolution was listed as the last standard in curricular guides due to religious conflict. Challenges with

colleagues and avoidance of human evolution were attributed to religious conflict regarding evolution education.

Research Questions Findings

As a narrative inquirer, open-ended questions were designed using a semistructured format to pursue the role of the active listener during interview processes. Through manual coding, four categories were revealed: factors and people that influenced participants into the field of science; approaches and strategies for teaching evolutionary theory; challenges teaching evolution; and support by administrators and colleagues. Within these four categories, 35 general themes and eight significant themes emerged. In seeking an understanding to retell events, answers to the following research questions:

The first research question asked the stories of science teachers teaching evolution. The category of factors and people who influenced participants into the field of science came inspiration from childhood events, family members who worked in the field of science, and authors of books on evolution. Former teachers, the effectiveness and ineffectiveness of former science teachers, job security, and recommendations from college advisors concluded themes for factors of influence. Influence to become a science teacher was attributed to several factors, although childhood events and family members in the field of science were most impactful regarding career decisions by participants.

The second research question asked how the stories of middle school science teachers revealed the practice of teaching evolution. Teaching methods and approaches, as well as teaching challenges, were informed regarding the teaching of evolution. Participants reported teaching evolution using microevolution and macroevolution as the basis for evidence. The topics of fossils, homologous structures, and vestigial structures offered specific lines of

evidence for teaching evolution. The topic of human evolution was reduced or omitted due to a self-reported lack of training and religious conflict. All participants mentioned one species of hominin, while 10% described two or more species of hominins as a teaching approach. Table 4 represents teaching approaches.

Table 4

Evolution Teaching Approaches

Teaching Approaches	Participants
Microevolution	P1, P2, P3, P4, P5, P6, P7, P8, P9, P10
Macroevolution	P2, P3, P4, P8, P9
Several species of Hominins	P4

The third research question asked what challenges, if any, were experienced while teaching evolution. Challenges reported by participants centered on religious and internal conflict. Religious conflict, while teaching evolution was described from stories of tension among students, colleagues, and parents of students, as illustrated in the stories of all participants. Participants told stories of students who avoided lessons, skipped school, and called teachers demonic names during the unit on evolution. Participants reported challenges from colleagues whose colleagues taught creationism, advised them to avoid evolution, did not teach evolution, and placed pressure on participants to defend teaching methods. The parents of participants' students brought challenges to the teaching of evolution as reported by participants as parents requested alternative assignments to replace lessons on evolution. Parents called and emailed the school principal to complain about teaching topics, and parents removed their child from the participants' class. The internal challenge noted was a lack of labs and real-life

examples on the topic of evolution. Stories of religious conflict included students, parents, and colleagues from participants while teaching evolution.

The fourth research question explored administrative support regarding evolution education. The category of support by administrators showed stories of verbal support once participants could defend teaching practices. While administrators questioned participants—following parent complaints—the lines of communication between teachers and administrators served to build support and clarify understandings of what evolution is and the state of evolution education. The support given by administrators was verbal reconciliation regarding parent complaints and meetings in which participants presented and defended teaching practices, as illustrated in the story of P9.

The fifth research question asked what the stories of science teachers revealed about support from colleagues regarding evolution education. Stories from participants exposed that collaboration was viewed as an invaluable tool for teaching evolution effectively by all participants. Alternatively, participants worked with colleagues who expressed opposition to the teaching of evolution. Such resistance prompted participants to be selective about which colleagues they would converse the topic of evolution, as illustrated in the story of P5 and P10. Participants told stories of supportive colleagues and of those who opposed the teaching of evolution—inclusive of fellow science teachers.

Chapter 4 Summary

In Chapter 4, the procedures for data collection, a description of the research methodology and analysis, and a presentation of the study findings from stories collected by teachers of evolution. Participants' stories were recorded, transcribed, and restoried in the study findings. Themes gleaned from participant stories revealed stories that gave pertinent details to

answer research and interview questions regarding the teaching of evolution. Stories from 10 participants shed light on how teachers navigated the teaching of evolution. Eight significant emergent themes were identified. Emergent themes regarding stories of teaching evolution were factors that led teachers into the field of science and evolution, stories and teaching approaches, the inclusion of human evolution, challenges faced by teachers of evolution, and the level of support by administrators and colleagues. These themes revealed patterns in stories of teachers from urban, suburban, and rural communities who taught evolution in a middle school setting.

Chapter 5 includes the interpretation of significant themes, the significance of the study findings, and the limitations of the study. Implications of the results for practice, theory, policy, and recommendations for teachers, administrators, and educational leaders will conclude the results of the study. Chapter 5 offers how the stories and analysis of this study posit recommendations to enhance the practice of teaching evolution for middle school science teachers.

Chapter 5: Discussion and Conclusion

Introduction

The purpose of this qualitative narrative inquiry was to explore the stories of middle school science teachers of evolution. Storied narratives centered on the pathways that led teachers into the field of science, teaching strategies, challenges experienced, and the history of support by administrators and colleagues. Throughout this chapter, connections of thematic and sub-thematic findings have linked the framework of this study: the scientific theory of evolution (Darwin, 1859) and the philosophical theory of cognitive dissonance (Festinger, 1957). This chapter provides a summation of results to answer five research questions and 10 interview questions. In addition, included are implications, limitations, and recommendations for future research regarding evolution education.

Summary of the Results

The purpose of this qualitative study was to reveal stories of middle school science teachers teaching evolution to determine teaching practices, challenges, and support from administrators and colleagues. The five research questions generated for this study were:

RQ1: What are the stories of science teachers teaching evolution in middle schools?

RQ2: What do the stories of middle school science teachers reveal about the practice of teaching evolution?

RQ3: What challenges, if any, have science teachers experienced or perceived while teaching evolution?

RQ4: What do the stories of science teachers reveal about administrative support regarding evolution education?

RQ5: What do the stories of science teachers reveal about support from colleagues regarding evolution education?

Research questions served as a guide to establish methods for data collection and analysis of the stories of middle school science teachers teaching evolution.

Data gathered from this study can be organized around eight significant themes. These themes promoted the application of several recommendations. The eight significant themes that emerged are:

1. Intrinsic motivation from science authors, childhood interests, and family members
2. Microevolution as a standard teaching approach to teach evolution
3. Macroevolution as an uncommon teaching approach for teaching evolution
4. Hominins as an uncommon teaching approach for teaching evolution
5. External challenges of religious conflict among students, colleagues, and parents
7. Internal challenges with colleagues and students
8. Support from administrators and colleagues
9. Need for support by administrators and colleagues

Middle school science teachers teaching evolution were motivated to provide students with comprehensive science education to include the teaching of evolution. The findings of this study contended that participants faced a multitude of challenges due to religious conflict. All participants narrated religious conflicts regarding evolution education within subgroups of students, colleagues, and parents, while no participants reported religious conflict with administrators. Support by administrators was evident (P2, P4, P5, P6, P7, P8, P9, P10), while support from colleagues was inconsistent. All participants narrated collaboration with colleagues

as invaluable. Additionally, participants reported colleagues who verbally spoke against the teaching of evolution.

Theories

Theories used to frame this study were the theory of evolution—a scientific theory—and cognitive dissonance—a philosophical theory. The theory of evolution proposed by Darwin (1859) and the theory of cognitive dissonance developed by Festinger (1957) provided scientific testimony and psychological evidence for challenges suggested in recent literature and study results. Physiological detections were detected in participants when the word evolution was mentioned (Bland & Morrison, 2015). Evidence from participant interviews supported the negation of evolution due to the philosophical theory of cognitive dissonance. Current and retired educators described avoiding the controversy of teaching evolution due to the conflict with religion and internal challenges, which could affect curricular decisions (Beggrow & Sbeglia, 2019).

Intrinsic motivation from science authors, childhood interests, and family members. Participants referenced the influence of childhood events and family members in the field of science in phrases such as, “I loved nature as a child," and “I grew up immersed in science.” Participants additionally stated they were influenced by family members who encouraged them to enter the field of teaching science and expressed concern for 21st century students as needing more outdoor opportunities. Authors such as Charles Darwin, Richard Dawkins, and Dr. Neil Shubin provided content knowledge that participants benefited from to teach evolution. Statements such as, “I taught myself what I should have learned in college or teacher preparation courses,” suggested a need for teacher training in evolution. Commentary provided by participants echoed the importance of being honest with students about the limits of science to

explain, “we do not know the answers to every question, and likely never will,” according to P9. Participants stated that scientists follow rigorous procedures to convey the most reliable and valid data known to humankind.

Microevolution as a standard teaching approach to teach evolution. The content inclusion of microevolution reported evolution on a small scale due to changes within one species. A review of participant comments revealed that similar teaching approaches, such as the topic of microevolution, served as introductory lessons for teaching evolution. The example of Peppered Moths, vestigial organs, and Darwin's Finches served as evidence for evolution. Fossil evidence was another topic presented as a conventional approach to teaching evolution. Microevolution served as the typical teaching approach as few participants reported teaching macroevolution.

Macroevolution as an uncommon teaching approach for teaching evolution. The content inclusion of macroevolution incorporated larger-scale connections regarding how organisms are most closely related—a scientific process of classification known as phylogeny. Teachers reported utilizing dichotomous keys, fossil evidence, and homologous structures as lines of evidence while teaching evolution (P1, P2, P3, P4, P6, P7, P9). Examples of microevolution exceeded examples of macroevolution and hominins—the evolution of human ancestry. The topic of microevolution revealed four significant themes. Alternatively, the topic of macroevolution disclosed one significant theme of hominins. Within the theme of hominins, just one hominin—Lucy: *Australopithecus afarensis*—was narrated in the results.

Hominins as an uncommon teaching approach for teaching evolution. At least 20 species of extinct hominins have been unearthed according to P4, although participants did not include hominins in the teaching of evolution or referred to a single example of hominins. The

example was Lucy, *Australopithecus afarensis*, as reported by participants who did teach hominins. Declarations such as, “I had no desire to cause an uproar" and “we did not talk much about human evolution," were revealed by P6. Participants suggested that the inclusion of hominins served as a point of contention to spark controversial behaviors during the teaching of evolution due to religious conflict.

External challenges of religious conflict among students, colleagues, and parents. The theme of religious conflict was prevalent, as reported by all participants who narrated conflict with students, parents, and colleagues during the teaching of evolution. Data revealed instances of parents who complained about the curriculum, avoidance of evolution by students and colleagues, and participants who felt pressured to defend the curriculum. Participants described the denominations of Jehovah’s Witnesses (P2) and Jesus Christ of Latter-day Saints (P6) as students who were “less accepting of biological evolution" (P2, P6). All participants reported conflict with religious beliefs among students (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10). In addition, conflict with religious beliefs with colleagues who taught creationism was reported by all participants (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10). Finally, conflict with religious beliefs with parents who requested alternative assignments during the unit on evolution was reported by 70% of participants (P1, P3, P4, P5, P6, P9, P10).

Internal challenges with colleagues and students. Participants described working with colleagues who avoided evolution and referred to evolution as *just* a theory. Referring to evolution as *just* a theory is a common misunderstanding, which incorrectly reduces the validity of the science (Orfinger, 2015). P3 reported two science teachers who taught creationism to students in a public-school setting. Additionally, students avoided lessons on evolution by being absent for school during the unit on evolution, refusing to complete assignments, and by turning

their chair to face the wall in defiance. Avoidance of evolution has been demonstrated by colleagues and students, as reported by 90% of participants (P1, P3, P4, P5, P6, P7, P8, P9, P10).

Support by administrators and colleagues. Participants reported collaboration among participants and colleagues as invaluable and practical (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10). Working with science teachers to create lesson plans and reduce workload was reported by 30% of participants (P1, P4, P9). Cooperation among participants and science teachers who held an understanding and acceptance of evolutionary theory created collaborative environments conducive to all. P1 referred to collaboration with a colleague as the most transformative period of their career teaching evolution. P4 stated that "Once I found a fellow science teacher who understood evolution, our united support allowed creativity to flourish." Collaboration and working with fellow science teachers provided instances of support during the teaching of evolution.

A need for support from administrators and colleagues. Administrators were supportive once clear lines of communication were in place (P3, P4, P5, P6, P8, P9, P10). Participants felt supported by administrators after lengthy conversations to describe the process of evolution and explain teaching practices and approaches (P3, P4, P9). P9 organized science teachers within the district as the religious conflict escalated to, "make sure creationism was not forced upon science teachers to teach in the classroom." P9 clarified feeling relieved when allowed to present evolution to administrators yet unnerved by the widespread misunderstandings that prevailed among school leaders.

Support for colleagues portrayed an environment of hostility (P1, P3, P4, P9, P10) and support (P1, P3, P4, P7, P9). P4 tried avoiding the topic of evolution with colleagues. Conversations, however, were unavoidable, "When I taught evolution, students would tell the

math teacher who brought it up at lunch just to challenge me," according to P4. P1 reported an English teacher who said, "She stopped me in the copy room and told me she could not believe I taught that stuff. I was mortified and did not know how to reply." Exchanges between science teachers who taught evolution were hostile among science teachers and other content teachers who cited religious conflict as a stressor.

Discussion of the Results

RQ1: What are the stories of science teachers teaching evolution in middle schools?

The participants engaged in this research question with stories of influences that led them into the field of teaching science. Intrinsic motivation served as a factor that led participants to teach science as authors of scientific books (P1, P2, P3, P4, P5, P8, P9), a childhood interest in science (P1, P2, P3, P4, P8, P9, P10), recommendations by family members (P1, P2, P4, P5, P8, P9, P10). The inspiration to enter the field led participants into a career lasting 10 or more years riddled with challenges of religious controversy. Science teachers who accepted and understood the principles of evolutionary theory continued to face challenges due to religious controversy surrounding the theory (Lynn et al., 2017). P4 expressed, "Since evolution was the last unit to teach, we rushed through it to prepare for state testing." Participants referred to the religious conflict as reasons for the unit on evolution to be at the end of the school year (P1, P4, P10). Participants revealed stories of entering the field of science from influences with a sense of excitement while revealing multiple internal and external challenges.

Additionally, a current study found that capable and competent teachers who reduced the content of evolution (Glaze, 2018). Teachers reported instances of reducing educational standards to avoid the controversy of evolution in science classrooms and keep administrators at bay (P1, P4, P10). P7 reported referring to evolution as *natural selection* to avoid using the word

evolution as a strategy for avoiding the controversy. The study findings aligned with earlier study conclusions that even though science teachers accepted evolution, they reduced the content to avoid the controversy (Friedrichsen et al., 2016; Heddy & Nadelson, 2013). P8 said that evolution taught indirectly allowed students to make discoveries. “I never said, this is how evolution works through natural selection" (P8).

Seminal works on cognitive dissonance supported the second emergent theme of books on evolution. Participants offered influence from authors such as Darwin, Dawkins, and Shubin (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10), while providing evidence of reduced time spent on evolutionary theory. P6 offered, “We do not talk much about human evolution except a bit about Lucy, who is over 3 million years old.” P4 referenced a book by Shubin, who described the human descent from apes as common knowledge and offered research of human similarities to fish anatomy. “It is ironic that when I teach similarities to fish, no one bats an eye, but if I teach similarities to primates, everyone loses their minds," narrated P4. Participants referenced authors of books on evolution and shared instances of dissonance through avoidance and challenges. Festinger (1957) referred to the act of knowing one thing while acting in opposition to such knowledge as *cognitive dissonance*. Studies conducted with high school biology teachers suggested dissonance as reasons for avoiding a topic they understood to be factual (Bland & Morrison, 2015). In the current study, dissonance was detected by participants who skimmed, skipped, or avoided the theory of evolution.

RQ2: What do the stories of middle school science teachers reveal about the practice of teaching evolution? Participants' narrated events resulted in three themes: microevolution, macroevolution, and hominins (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10). The second emergent theme of microevolution as a common topic used to teach evolution is consistent with a study by

Sickel & Friedrichsen (2013). Findings from this study suggested that microevolutionary examples exceed those of macroevolution. Teachers accept microevolutionary processes while rejecting macroevolutionary processes (Sickel & Friedrichsen, 2013). The theme of microevolution as a substantial teaching topic is evident in an earlier study of science teachers (Rosengren., 2012). The findings of this study revealed that the teaching of microevolution was the most common method for teaching evolution. Topics taught by participants include dichotomous keys (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10), vestigial structures (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10), Darwin's Finches (P1, P2, P3, P4, P7, P9, P10), and fossil evidence (P1, P2, P3, P4, P6, P7, P9).

The third emergent theme of macroevolution became a lesser-known topic used for teaching evolution. Padian (2010) indicated that the teaching of macroevolution was a revolutionary and effective movement by science teachers' teaching evolution. Macroevolution involves connections between varied species of organisms to represent significant scale changes among organisms (Sickel & Friedrichsen, 2013). Participants referred to one example of macroevolution: homologous structures to present skeletal structures of various mammals for comparison (see Figure 2; P1, P2, P3, P4, P5, P6, P7, P8, P9, P10).

The fourth emergent theme of hominins—human evolution—as part of the evolution curriculum was supported by studies that suggested reduced time spent on human evolution. Participants referred to a single species of hominin, Lucy, *Australopithecus afarensis*, to teach human evolution (P5, P6, P7, P8, P9, P10). Cognitive science researchers suggested that learning evolution in the context of human evolution enhanced understanding, although it has been void in science classrooms (Beggrow & Sbeglia, 2019). These findings parallel with studies that suggested human evolution was the most controversial and least discussed topic in U.S. science

classrooms (Bravo & Cofré, 2016; Friedrichsen et al., 2018). Narration by participants concluded they felt fortunate to teach evolution and reduced the teaching of *human* evolution due to religious conflict (P1, P4, P6, P7, P10).

RQ3: What challenges, if any, have science teachers experienced or perceived while teaching evolution? From this question, the fifth emergent theme of religious conflict emerged. Religious conflict is consistent with challenges faced by science teachers who taught evolutionary theory. Participants reported conflict surrounding religious beliefs among students (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10), colleagues who taught creationism (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10), and parents who requested alternative assignments for those on evolution (P1, P3, P4, P5, P6, P9, P10). Students practiced avoidance and became argumentative during lessons on evolution. Religious conflict among colleagues revealed the most storied events among colleagues who referred to evolution as *just* a theory and taught creationism. Parents requested alternative assignments to replace lessons on evolution.

Short and Hawley (2015) referred to the religious conflict as the number one challenge of teaching biological evolution. Results from the study suggested that science teachers experienced pressure to conform to societal norms even when conflicting with mandated standards (P4, P5, P6). P4 stated, “We did not have enough time to get deep into evolution.” P6 said, “I quickly learned to avoid talking about evolution with certain colleagues.” The challenge of teaching evolution amidst religious conflict aligned with earlier studies that religious beliefs prompted misconceptions about evolution (Miles & Marinello, 2010). Findings within narrated themes of this study labeled religious conflict with students, colleagues, and parents as significant challenges for teaching evolution.

RQ4: What do the stories of science teachers reveal about administrative support regarding evolution education? Stories revealed a seventh emergent theme of support by administrators and colleagues regarding the teaching of evolution. As represented in Figure 1, high school biology teachers reported feeling less supported by parents than they did by administrators, according to Friedrichsen (et al., 2016). The findings of this study concluded that students, colleagues, and parents were least supportive (P1, P2, P3, P4, P5, P6, P8, P9, P10), while administrators became supportive once a clear line of communication about teaching practices was in place (P3, P4, P5, P6, P8, P9, P10). Administrators supported teachers who were influential in their content area and communicated with participants regarding steps taken to teach evolution, according to participants (Hawley & Sinatra, 2019)**.**

RQ5: What do the stories of science teachers reveal about support from colleagues regarding evolution education? Religiosity was the determining factor to decide if participants felt supported or unsupported while teaching evolution (P1, P2, P3, P4, P5, P6, P8, P9, P10). P6 stated, "Once I found a science teacher who understood evolution, I felt more confident to teach it." The theme of support was reported by Hall & Woika (2018), who stated their empathy for teachers who avoided evolution due to a lack of support systems to teach the controversy. Participants practiced avoidance among colleagues who voiced opposition to evolutionary theory (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10). P5 said, "We had an awkward conversation about science versus religion, and I realized that while you should always take advice, sometimes you should be cognizant that people feel strongly about their beliefs and thoughts about how you approach sensitive subjects." Alternatively, participants felt supported by colleagues who were taught science and accepted the theory of evolution, which led to collaborative practices (P3, P4, P5, P6, P8, P9, P10).

Religious conflict leading to cognitive dissonance persists as a significant challenge for the teaching of evolution. These findings correlate with acceptance rates for evolution among U.S. citizens among the lowest of all developed nations (Hawley & Sinatra, 2019). The study results indicated ongoing challenges of external challenges and internal challenges for teaching the theory of evolution (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10). As a result, students receive incomplete science education to the detriment of the future of scientific literacy in the U.S. (Bravo & Cofré, 2016, & Glaze, 2018). All participants in this study, however, revealed a passion for teaching evolution. A multitude of barriers and a lack of support—both linked to religious conflict—remain challenges for science teachers.

Additionally, the absence of human evolution and the presence of cognitive dissonance is present among high school biology teachers. The findings of this study are unique to participants of this study as a reminder to avoid overgeneralization. However, results from data in the current study have prospective transferability. Fellow researchers can utilize data in various research settings based on these recommendations. A study using quantitative analysis could compare middle school science teachers who utilize religious sensitivity activities compared to those who do not. Religious sensitivity activities allowed high school biology teachers to address the challenges presented in this study (Pobiner et al., 2018). A case study designed to observe teaching approaches would reveal teaching approaches. In addition, a case study to analyze preservice teaching programs and professional development plans may reveal program effectiveness. Future researchers have permission to use the current data for comparison purposes or further studies of any methodology.

Teaching approaches and challenges varied among all participants who reported religious conflict and a lack of support as barriers to teaching evolution. The face-to-face interviews with

participants revealed that the teaching of evolution remains a controversial topic to teach due to religiosity (P1, P3, P4, P5, P9, P10). Participants reported teaching with challenges and practicing avoidance of teaching evolution (P1, P4, P6, P10). Alternatively, the open-door policy of conversations about the religious conflict was a strategy for overcoming challenges (P2, P4, P7, P8, P9). Teachers may continue to skim or skip the theory of evolution, resulting in an incomplete education for students. Teachers may teach evolution and continue to face barriers such as avoidance, religiosity, and dissonance reported by all participants.

Results from this study may have occurred due to cognitive dissonance, which means that science teachers are instinctively reducing or avoiding evolution content to avoid the controversy. Religiosity due to personal or perceived beliefs in others have historically and presently conflicted with the theory of evolution. Friedrichsen et al. (2016) reported that human evolution was the most controversial of all topics within the study of evolution, which paralleled the results of this study. Teachers self-reported a lack of good labs as reasons for avoidance (Friedrichsen et al., 2016). However, the results of this study highlighted religious conflict as the most significant challenge for teaching evolution.

Discussion of the Results in Relation to the Literature

The theory of evolution is a controversial topic—among science teachers in particular—for decades in the U.S. with declines in acceptance rates (Nadelson & Hardy, 2015). Findings from this study support the idea that science teachers require additional preparation, support measures, professional development opportunities, and resources to overcome challenges reported in current research. Curricular developers of college teacher programs who consider the role evolution plays in scientific literacy should consider the challenges science teachers have endured (Hall & Woika, 2018). The stories of science teachers revealed the challenge of

religious conflict while teaching evolution in a middle school setting. The literature recommended providing teachers with strategies to overcome the controversy, understand the science, and teach with religious sensitivity measures are proactive measures for teaching evolution (Pobiner et al., 2018). Participants who discussed religion openly—free of indoctrination—reported constructive conversations regarding evolution (P2, P4, P7, P8, P9). Taking steps to prepare teachers for teaching evolution enhance teaching practices and reduce conflict.

Dissonance and religious conflict were determined to be challenges that infuse the teaching of evolution for middle school science teachers in this study. Specifically, ongoing challenges have created dissonance to reduce the teaching of evolution and human evolution. For example, data from this study from all participants revealed scant instances of human evolution as topics of study. Participants who did teach human evolution used a single example within one class period (P1, P2, P3, P5, P6, P7, P8, P9, P10). Human evolution invokes a greater sense of conflict and therefore requires more training preparation to enhance the effectiveness of learning and teaching practices (Pobiner et al., 2018). P4 reported problem-solving by using internet sources to learn about hominins. Problem-solving ways to traverse potential conflicts support overcoming barriers.

Results from this study reinforced a need for science teachers to have training initiatives and resources to navigate challenges. Training provided for high school biology teachers provided tools to enhance teaching strategies and generate empathy for student learning of evolutionary theory (Bravo & Cofré, 2016). The complexities of evolution include small and large-scale changes in nature. Within the teaching of microevolution—participants reported four topics. Within the teaching of macroevolution—participants reported one topic. This study aligns

with research literature that suggested that the importance of teaching macroevolution is an essential component of scientific literacy and medical advances (Rosengren, 2012). Providing in-service training on macroevolution connects humans to all kingdoms of life using family trees (see Figure 3). There were no studies available that held in-service training sessions on evolution as ineffective. Several studies provided data on the benefits of in-service regarding evolution (Bramschreiber, 2014; Bravo & Cofré, 2016; Hermann, 2018).

Current challenges faced by middle school science teachers corresponded with studies conducted with high school biology teachers. High school teachers reported challenges of religious conflict and referred to them as *cultural barriers* (Pobiner et al., 2018). For example, cultural barriers are worldviews that stem from multi-generational practices evident in historical and current studies. Additional evidence for why evolution remains controversial pointed to religiosity and revealed dissonance as a challenge for teachers to overcome (Glaze, 2018). Science teachers experience dissonance when they understand the validity of evolutionary science; however, they reported skimming or skipping content. Comparative to findings, all participants in this qualitative study offered stories of religious conflict among students, parents, and colleagues. The literature stated that teachers feel underprepared to address the controversy of evolution and lack of strategies to address cultural barriers and personal dissonance (Bramschreiber, 2014). Participants in this study reported teaching themselves about evolution (P1, P2, P3, P4, P6, P8, P9, P10). P3 said, “I learned about evolution while teaching evolution. These were concepts I should have learned before teaching.” Data from recent studies on high school biology teachers revealed similar challenges reported in this study by middle school science teachers regarding evolution.

Limitations

The limitations of this qualitative study are as follows. The small sample size of 10 participants gained access to a limited number of storied events. Research findings should not be generalized to a large population due to the limited sample size used in this study. However, the use of a small sample size for this qualitative study was preferred to gain a more comprehensive picture of storied events (Kim, 2016).

The limitations of truthfulness and bias exist in this research process. The challenge for a narrative researcher is to find meaning in storied events and retold events accurately while remaining aware of personal bias (Kim, 2016). As a former middle school science teacher, I recognized personal bias from teaching evolution. It was imperative to explore numerous research studies to learn the state of evolution education in various educational settings. The truthfulness of participant responses is unknown since it is impossible to know if participants gave honest answers to the 10 interview questions. The creation of open-ended questions provided space for participants to be forthright. However, the most significant limitation of this study is that it did not examine teaching approaches of participants' teaching evolution, as suggested for further research.

The final limitation of personal bias as a former science teacher was transparent when gathering and analyzing data. My personal bias as a teacher of evolution brought personal truths that may or may not be reflective in participant stories. Kim (2016) recommended disclosing this information within the study and remaining sensitive to how this personal bias could affect study results. Therefore, to reduce bias within this study, generalized statements were cited by existing studies. Evolution education can be taught with religious sensitivity to develop creative thinkers to make responsible choices for the advancement of humanity without sacrificing personal belief

systems. The prospect of enhancing evolution education is achievable with increased communicative practices. The role of a narrative researcher required serving as the lead instrument. Narrative inquiry begins with a sense of wonderment to discover experience as a story (Clandinin, 2007). The role of a narrative inquirer was to gain the full stories of events that occurred surrounding the teaching of evolution. Responsibilities were to conduct ethical research indicative of biases, limitations, and delimitations of the study. Reporting and understanding these variables assist in personal and reader understandings about the study.

Enthusiasm for this research topic came from experiences teaching evolution in a middle school setting. In the 17 years, I taught middle school, and evolution was the unit that students became most excited. It was within this unit I taught students the validity and downfalls of science as limited. I was not afraid to tell students when I did not know the answer or that even the greatest scientists of the world did not know the answer. This lack of finality created connections of hope for students to make personal discoveries and offer unique imprints on their time spent on earth. Middle school students are highly impressionable young adults with the ability to delineate between truths and falsehoods. They must have exposure to all options as future leaders of the world and deserve access to each bit of knowledge teachers can convey.

Implication of the Results for Practice, Policy, and Theory

Data analysis produced eight significant themes. Major themes related to RQ1 included: childhood events, family influence, and authors of science books. The themes related to RQ2 were microevolution, macroevolution, and hominins. The theme related to RQ3 was the external challenges of religious conflict and internal challenges from colleagues and student avoidance. Themes related to RQ4 and RQ5 were the level of support by administrators and colleagues. This

qualitative study filled a gap in the literature involving stories of middle school science teachers teaching evolution.

The choice of teaching approaches is a significant aspect gleaned from narrations. Microevolution overshadowed macroevolution, hominins, and speciation as topics used to teach evolution. These findings suggest a need for implementation of these topics into preservice teaching programs and professional development plans. The literature highlighted these topics as neglected by high school biology teachers who focused on specific examples of microevolution as a standard approach for teaching evolution (Rosengren, 2012). In addition, the literature suggested that teachers taught microevolution more frequently than other topics due to the controversy (Sickel & Friedrichsen, 2013). The dissemination of teaching approaches utilized by middle school science teachers will contribute to science teachers and administrators involved with scientific literacy. Narrated stories provided insight for enhancing science education. The following implications for the study are how the results apply to practice, policy, and theory.

To apply strategies from thematic evidence provided in this study, training on macroevolution and hominins for science teachers and administrators are recommended. This training should be available for current and preservice middle school science teachers. In conjunction with a comprehensive curriculum to build content knowledge, science teachers require strategies to overcome dissonance and religious conflict. Furthermore, the use of religious sensitivity as part of teacher training is recommended based on study results and findings from the literature. Application of criteria from thematic data applies to science teachers, administrators, and those concerned with enhancing evolution education.

The significant themes supported recommendations for practice to enhance evolution education for middle school science teachers. The second and third major themes revealed a focus on microevolution. The literature suggested that teachers taught microevolution more frequently than other topics due to the controversy (Sickel & Friedrichsen, 2013). Therefore, it is recommended that teacher training is offered to include a focus on macroevolution for teachers to practice concepts, gain exposure to lessons, experiment with resources, and be provided with resources to support the curriculum. The fourth theme disclosed a negation on the topic of hominins—extinct human ancestors. As recommended by the research, within the branch of evolution education, the specific focus of human evolution is obscured or disregarded among science teachers in U.S. classrooms (Beggrow & Sbeglia, 2019). Likewise, teacher training regarding hominins is recommended in addition to macroevolution to expose current teachers and those training to become teachers to gain access to learning about human ancestry. The fifth theme of religious conflict suggested the significance of this topic. The presence of religious conflict is a significant barrier in evolution education (Barnes & Brownell, 2016). Religious sensitivity activities require training implementation to provide space for belief systems in harmony with science (Pobiner et al., 2018). The act of avoidance should no longer be an acceptable strategy for dealing with challenges that arise in evolution education. Theme six related to difficulties experienced with students while teaching evolution. Teachers should be made aware of typical behaviors and require training to respond effectively and with sensitivity to overcome the predispositions that students hold towards the theory of evolution. Theme eight cited a need for resources that should be provided for middle school science teachers. Along with an understanding that pedagogical content knowledge is relative to teacher effectiveness and the need for professional development regarding evolution education, teachers need access to

resources. By providing teachers with time to review free educational resources and given training opportunities, teachers will enhance teaching practices. Additionally, resources expose common misconceptions surrounding evolution to teach evolution effectively.

To apply these themes as a scholar, I would like to publish my paper in a peer-reviewed journal or attend the state science conference to share results. Findings from this study produced two policy recommendations. The first recommendation is the implementation of professional development regarding macroevolution and hominins. The topics of macroevolution and hominins require implementations within teacher training programs for in-service teachers of middle school science. Macroevolution provides vital evidence for the understanding of life on a large scale. The willingness to teach macroevolution connects with confidence and content knowledge enhanced by teacher training programs (Sickel & Friedrichsen, 2013). The study of hominins deepens understandings for learners. Training programs should include human evolution to offer an increased understanding of evolutionary theory (Beggrow & Sbeglia, 2019).

The second recommendation for policy implementation addresses religious sensitivity. Based on theoretical evidence, science teachers and administrators should obtain training opportunities for evolution through an awareness of cognitive dissonance to address religious conflict. As a practitioner, I would like to apply my findings to science teaching practices. Training initiatives will provide teachers of evolution instructional practices that will reduce avoidance of educational policies (Barnes & Brownell, 2016). The proposal of religious sensitivity training was offered by Pobiner et al. (2018), who referred to the religious conflict as an ongoing challenge. Results from religious sensitivity lessons showed a better understanding of evolutionary concepts compared to test results from teachers who did not implement such activities. The integrity of evolutionary biology is dependent upon the delivery of content high

in accuracy and breadth (Berkman & Plutzer, 2015). Educational leaders should review these findings and consider appropriate policy implementation. Science teachers need additional educational resources to help them overcome potential conflicts to bridge the divide between religion and science.

The theory of evolution (Darwin, 1859) and the theory of cognitive dissonance (Festinger, 1957) provided framework to apprise the results of the study. These theories are evident within the significant themes of the study. The second and third themes: microevolution as a standard teaching approach to teach evolution and macroevolution as an uncommon teaching approach for teaching evolution are supported by the framework. The theory of evolution includes both microevolution and macroevolution, although a teaching focus has been dedicated to microevolution. Reasons for less time dedicated to teaching macroevolution has been suggested by studies reviewed in the literature review and the results of this study. These theories indicate what the science is and why it is being negated. Explained how dissonance is a factor in the choice of reducing content to avoid the controversy (Bland & Morrison, 2015).

Recommendations for Further Research

The purpose of this qualitative narrative inquiry was to explore life stories of middle school science teachers teaching evolution. Participants reported a hyper-focus on microevolution and a negation of macroevolution. Further, religious conflict arose between participants and students, participants and parents, and participants and colleagues. Support among administrators was reported as adequate if open lines of communication were present. Support efforts among colleagues were dependent upon personal worldviews and content expertise. Further studies that observe middle school science teachers' teaching evolution may determine teaching approaches in a middle school setting.

Professional development opportunities are recommended for current science teachers to gain exposure to online resources, which are free and accessible. The use of interactive websites aligns with 21st-century standards of technology in the classroom. Resources to teach evolution will provide examples of macroevolution, hominins, and speciation to provide comprehensive units on evolution. Science teachers are currently using textbooks and authors of science books and would benefit from exposure to multiple resources. A comparative study conducted to explore the stories of science teachers at technological schools and private schools would provide useful data for teaching evolution. Case studies on teaching evolution could provide answers to specific questions about evolution education. An ethnographic study may be useful to understand science teachers' worldviews, principles, and mindsets. Additionally, researchers may choose to conduct observations of science teachers' teaching evolution to understand challenges and experiences better.

Based on the results of this study, researchers may choose to examine the effects of middle school science teachers who avoid religious conflict. According to Glaze (2018), studies that focus on preservice secondary biology teachers should examine worldviews among private schools to compare to public schools. Studies designed to compare teachers who practice religious sensitivity regarding evolution versus those who practice avoidance will provide evidence on the effectiveness of such activities. Questions of how religion affects teaching practices using pre and posttest on cognitive dissonance would enhance the validity of this study.

This study could be modified to focus on preservice teachers of middle school science, as studies of high school biology teachers encompass most of the research. Such variations would contribute to the body of literature regarding evolution education. Prospective areas of the study provided rational concerns such as practicality, accessibility, or convenience. A final

recommendation is to conduct a qualitative study to compare teachers from various socioeconomic backgrounds to determine acceptance rates of evolution. A final recommendation is to conduct a qualitative study to compare teachers from various socio-economic backgrounds to determine acceptance rates of evolution. Recommendations arose from gaps in the literature with limitations considered to offer suggestions for supporting evolution education to enhance scientific literacy nationwide.

Conclusion

The purpose of this qualitative narrative inquiry was to explore life stories of middle school science teachers teaching evolution. The general problem is that middle school science teachers are experiencing challenges while teaching evolution. Specifically, these challenges include the controversy surrounding the theory of evolution, conflicting worldviews, anti-evolution movements, the level of pedagogical content knowledge, educational resources, and a lack of support towards the topic of evolution. The five research questions created for this study were:

RQ1: What are the stories of science teachers teaching evolution in middle schools?

RQ2: What do the stories of middle school science teachers reveal about the practice of teaching evolution?

RQ3: What challenges, if any, have science teachers experienced or perceived while teaching evolution?

RQ4: What do the stories of science teachers reveal about administrative support regarding evolution education?

RQ5: What do the stories of science teachers reveal about support from colleagues regarding evolution education?

Ten participants from public middle schools in the Pacific Northwest participated in this study with experience at the time of the study between 11 and 30 years of experience teaching middle school science. The data collection consisted of face-to-face interviews with participants and member checking. Research instruments were 10 interview questions and a personal reference as the one who analyzed stories to rewrite them in a meaningful context. The recorded interviews served as data were manually transcribed and analyzed to enact social skills and avoid technological limitations. The eight significant themes that emerged are:

1. Intrinsic motivation from science authors, childhood interests, and family members
2. Microevolution as a standard teaching approach to teach evolution
3. Macroevolution as an uncommon teaching approach for teaching evolution
4. Hominins as an uncommon teaching approach for teaching evolution
5. External challenges of religious conflict among students, colleagues, and parents
6. Internal challenges with colleagues and students
7. Support from administrators and colleagues
8. Need for support by administrators and colleagues.

The findings of this study answered five research questions. The participants in this study revealed stories of how they became a science teacher, teaching approaches to teach evolution, and teaching challenges, and levels of support by colleagues and administrators. Clear lines of communication between teachers and administrators provided support for teaching evolution. Colleagues posed significant challenges for science teachers' teaching evolution due to religious conflict. Additionally, results exposed a need for professional development for preservice and current teachers of evolution in a middle school setting. Professional development opportunities

are recommended based on an awareness of cognitive dissonance, content knowledge of evolution, and strategies to overcome religious conflict.

Evolution is the framework of biology to prepare future leaders for the advancement of medicine and to create an environment of sustainability (Ha et al., 2015). Results from this study provided evidence to answer the question: What do the stories of middle school science teachers reveal about the practice of teaching evolution? The participants narrated stories to reflect teaching approaches and challenges of teaching evolution. Scientific literacy is dependent on science teachers who accept the theory of evolution and have adequate support systems in place to be effective educators (Vazquez & Friedhoff, 2017). Results from the study concluded that participants would benefit from professional development opportunities. Such results infer from reports of microevolutionary processes mentioned as teaching approaches. Participants less mentioned the topics of macroevolution, hominins, and speciation (see Table 4). Consequently, the study concluded that the topic of evolution needs teacher training courses and professional development opportunities.

The results of the study revealed storied events of how middle school science teachers felt supported teaching evolution. Prioritizing evolution in the science curriculum will occur from support systems needed for future generations (Short & Hawley, 2015). Middle school science teachers are experiencing challenges that have permeated evolution education for decades. Reduced curriculum, religious conflict from parents, students, and colleagues, and exclusion of hominins are indicators of needed support for middle school science teachers. Science teachers are avoiding conversations about evolution with colleagues to reduce conflict. Teaching approaches center on individual processes in evolution—microevolution—resulting in an incomplete education for middle school science students. To have an incomplete

understanding of evolution is to have an incomplete understanding of how science works (Vazquez, 2017). As a researcher, I question why the topic of evolution remains controversial. I presume a need for training and support systems to enrich evolution education. Teachers and administrators should collaborate to overcome challenges and enhance evolution for the advancement of scientific literacy.

Human ancestry of extinct species—hominins—is the most significant point of contention within evolution education. Science students need exposure to the science of human ancestry. Educational research suggests that human evolution should be incorporated into evolution education to increase the understanding of change over time (Beggrow & Sbeglia, 2019). This research of middle school science teachers mimicked research conducted on high school biology teachers with a lack of attention to the study of hominins. Teachers are barely mentioning exciting discoveries dating early hominins back as far as six million years old. Data are available to understand how humans evolved as hunters and gathers, how our early ancestors discovered fire, and pathways of migration out of Africa. These are stories that students deserve to hear and decide for themselves whether to understand and accept what students in other countries already know.

The state of evolution education is promising as the quality of online resources are accessed and shared within a community of learners. My passion for the study of hominins came from first learning about them in college. Once students understand the plethora of fossil evidence available on hominins, the science becomes more natural to digest. The challenges that teachers continue to endure in evolution education require educational opportunities to address misconceptions, enhance teaching approaches, and brainstorm methods for developing support systems.

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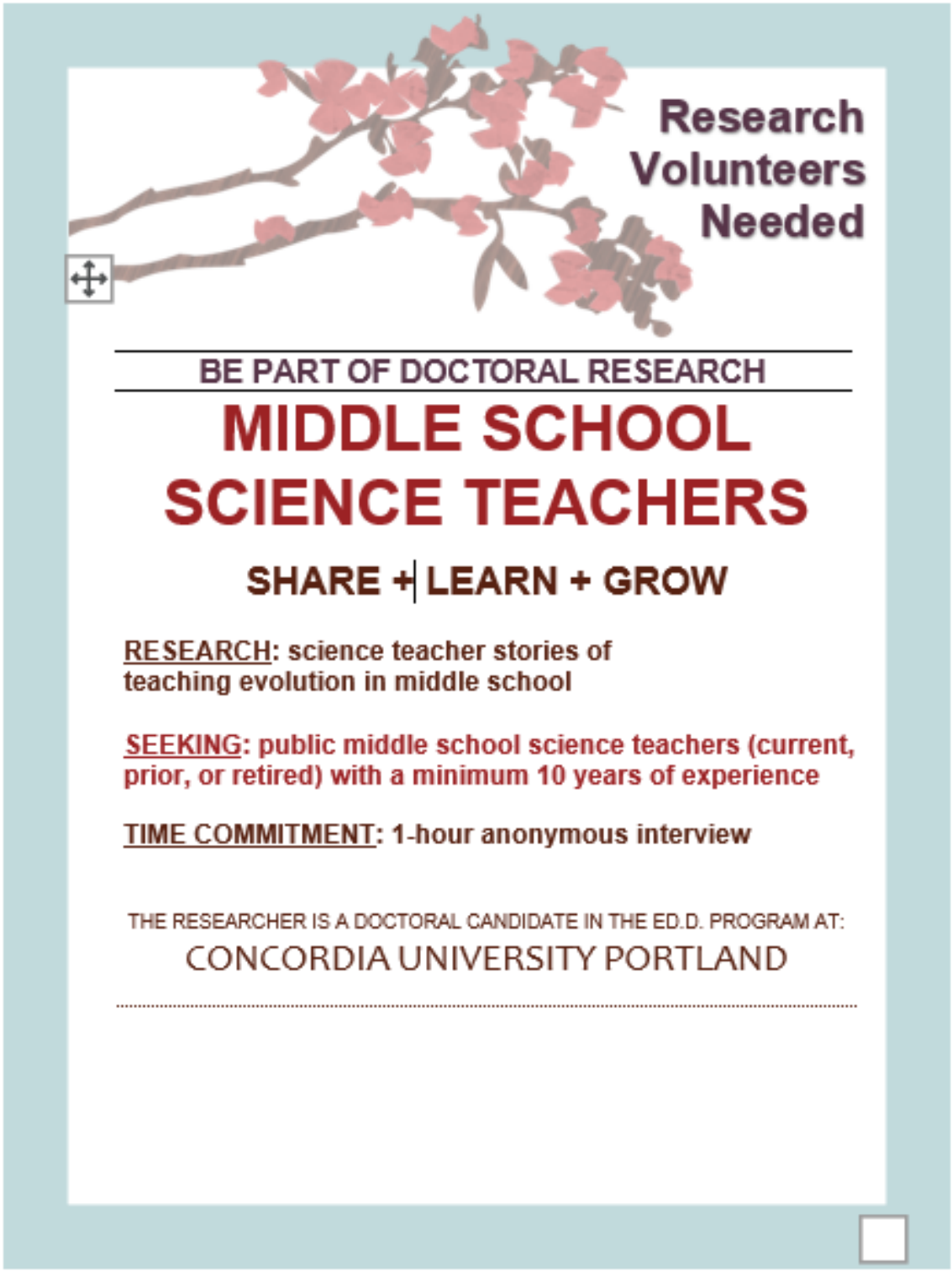
Appendix A: Flyer



Appendix B: Informed Consent

Informed Consent: Participants 18 years of age and older

Greetings,

My name is Victoria Klahn and I am a student at the Concordia University working on an Ed.D. in higher education. I am conducting a research study entitled The Lived Experiences and Stories of Science Teachers Teaching Human Evolution in Middle School: A Narrative Design.

The potential for the impact of these stories being retold is to learn from genuine experiences to enhance the field of middle school science education. Your story is unique and invaluable to educational research. Your story will shed light on how evolution has been taught in middle school. Stories told and retold will benefit anyone interested in evolution education including students, science teachers, parents, administrators, and researchers of evolution education.

The purpose of this qualitative study with a narrative inquiry design is to explore the stories of science teachers teaching evolution in middle schools. Your participation will involve about 30-45 minutes of answering questions and follow-up email exchanges to clarify answers. You will be one of 10 teachers participating in this study.

Your participation is appreciated, but I acknowledge that the questions I am asking are personal in nature. You are free at any point to choose not to engage with or stop the study. You may skip any questions you do not wish to answer. This study is not required and there is no penalty for not participating. If at any time you experience a negative emotion from answering the questions, I will stop asking you questions.

In this research, there are no foreseeable risks to you. This information will not be distributed to any other agency and will be kept private and confidential. The only exception to this is if you tell me abuse or neglect that makes me seriously concerned for your immediate health and safety.

Although there may be no direct benefit to you, a possible benefit from your being part of this study is your contribution to educational research, a deep reflection of your teaching legacy, and the opportunity to be part of scholarly research. If you have any questions about the research study, please email me [redacted]. For questions about your rights as a study participant, or any concerns or complaints, please contact the Institutional Review Board at [redacted].

As a participant in this study, you should understand the following:

1. You may decide not to be part of this study or you may want to withdraw from the study at any time. If you want to withdraw, please email me at [redacted].
2. Your identity will be kept confidential during the study and when and if the study has been published.
3. Victoria Klahn, the researcher, has fully explained the nature of the research study and has answered all your questions and concerns.
4. If interviews are conducted, you give permission for the researcher, Victoria Klahn, to record them. The information from these recorded interviews may be transcribed, and the data will be coded to assure that your identity is protected.
5. I will use codes for participants so no names will be released. All interview responses will be transcribed, saved as an encrypted file, and password protected. Audio recordings will be saved in the computer as an encrypted file, and password protected. Only I will have access to the computer used in this research. Your name and responses as well as video recordings will be kept in a secure location so no other people can access these files. This information will not be distributed to any other agency and will be kept private and confidential. The only exception to this is if you tell me abuse or neglect that makes me seriously concerned for your immediate health and safety. All interview files will be deleted after three years upon publication of study.
6. The results of this study may be published.

By signing this form, you agree that you understand the nature of the study, the possible risks and benefits to you as a participant, and how your identity will be kept confidential. When you sign this form, this means that you are 18 years old or older and that you give your permission to volunteer as a participant in the study that is described here.

(☐) I accept the above terms. (☐) I do not accept the above terms. (CHECK ONE)

Signature of the research participant _____ Date _____

Signature of the researcher _____ Date _____

NOTE: For studies that employ an *online* informed consent (instead of a signed paper informed consent), different processes may apply. Please review:
GUIDANCE – Online Surveys and IRB Review.

Appendix C: Interview Questions

Interview Questions

1. Please tell me the story of how you became a science teacher.

2. Which experiences were most impactful that led you to the field of science?

3. Please share with me the story of who has been most influential in your science teaching career.

4. Could you share with me a few stories of teaching evolution in the middle school over the past 10 years?

5. Please tell me the story of *how* you prepare to teach the theory of evolution.

6. How would you describe the most memorable events in the past 10 years of teaching evolution?

7. If applicable, could you describe how you incorporate *human* evolution into the topic of evolution?

8. Have there been instances where you felt empowered or limited by administrators in your teaching practice regarding evolution?

9. Have you ever sought out support from colleagues regarding the teaching of evolution?

10. Have there been any challenges in teaching evolution in your experience? If yes, would you share the story with me?

Appendix D: Categories, Themes, and Participant Codes

Categories, Themes, and Participant Codes

Interview Categories	General Themes and Participants' Codes
Factors and people that influenced the field of science teaching	*Intrinsic motivation:* Authors of scientific books (P1, P2, P3, P4, P5, P8, P9) Childhood interest in science (P1, P2, P3, P4, P8, P9, P10) Family members (P1, P2, P4, P5, P8, P9, P10) *Extrinsic motivation:* Former teachers/ professors (P1, P2, P4, P5, P8, P9) Effective science teachers (P1, P2, P9, P10) Job security (P1, P4, P10) College advisor recommendation (P1, P4, P8)
Strategies and approaches for teaching evolutionary theory	*Microevolution:* Dichotomous keys (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10) Vestigial structures (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10) Darwin's Finches (P1, P2, P3, P4, P7, P9, P10) Fossil evidence (P1, P2, P3, P4, P6, P7, P9) *Macroevolution:* Homologous structures (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10) Phylogeny (P2, P4, P9)

	Hominins (Human Evolution): One species of hominin only, Lucy, *Australopithecus afarensis* (P1, P5, P6, P7, P8, P9, P10) Human migration out of Africa (P2, P4, P9) Lucy and several species of Hominins (P2, P4, P9) Foramen magnum (P2, P3, P4) Hominin anatomy (P2, P3, P4)
Challenges teaching evolution	*Religious Conflict:* Conflict with religious beliefs among students (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10) Reported colleagues who taught creationism (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10) Parents requested alternative assignments due to religious conflict (P1, P3, P4, P5, P6, P9, P10) Students called them demonic names (P5, P8) Jehovah's Witnesses students were less accepting than other students (P2) Jesus Christ of Latter-day Saints students were less accepting than other students (P6) *External challenges:* Parents complained via email or phone call (P1, P4, P5, P6, P9, P10) Parents called the principal to complain (P1, P3, P4, P6, P9, P10)

	Had one or more student removed from their team and onto another (P1, P4, P10)
	Internal challenges:
	Colleagues who avoided evolution (P1, P3, P4, P5, P6, P7, P8, P9, P10)
	Students avoided lessons on evolution (P1, P2, P3, P4, P6, P9, P10)
	Lack of labs and real-life examples (P1, P3, P4, P6, P9, P10)
	Felt pressured to defend teaching methods (P1, P3, P4, P6, P9, P10)
Level of support by administrators and colleagues	*Support:*
	Referred to collaboration as an invaluable tool (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10)
	Administrators were supportive if clear lines of communication were in place (P3, P4, P5, P6, P8, P9, P10)
	Lack of support:
	Had colleagues who said they should not teach evolution (P1, P2, P3, P4, P5, P6, P7, P8, P9, P10)
	Administrators questioned teaching practices (P3, P4, P5, P6, P8, P9, P10)

Appendix E: Statement of Original Work

The Concordia University Doctor of Education Program is a collaborative community of scholar-practitioners, who seek to transform society by pursuing ethically informed, rigorously-researched, inquiry-based projects that benefit professional, institutional, and local educational contexts. Each member of the community affirms throughout their program of study, adherence to the principles and standards outlined in the Concordia University Academic Integrity Policy. This policy states the following:

Statement of academic integrity.

As a member of the Concordia University community, I will neither engage in fraudulent or unauthorized behaviors in the presentation and completion of my work, nor will I provide unauthorized assistance to others.

Explanations:

What does "fraudulent" mean?

"Fraudulent" work is any material submitted for evaluation that is falsely or improperly presented as one's own. This includes, but is not limited to texts, graphics and other multi-media files appropriated from any source, including another individual, which are intentionally presented as all or part of a candidate's final work without full and complete documentation.

What is "unauthorized" assistance?

"Unauthorized assistance" refers to any support candidates solicit in the completion of their work, which has not been either explicitly specified as appropriate by the instructor, or any assistance that is understood in the class context as inappropriate. This can include, but is not limited to:

- Use of unauthorized notes or another's work during an online test
- Use of unauthorized notes or personal assistance in an online exam setting
- Inappropriate collaboration in preparation and/or completion of a project
- Unauthorized solicitation of professional resources for the completion of the work.

Statement of Original Work (continued)

I attest that:

1. I have read, understood, and complied with all aspects of the Concordia University–Portland Academic Integrity Policy during the development and writing of this dissertation.

2. Where information and/or materials from outside sources has been used in the production of this dissertation, all information and/or materials from outside sources has been properly referenced and all permissions required for use of the information and/or materials have been obtained, in accordance with research standards outlined in the *Publication Manual of The American Psychological Association.*

Victoria L. Klahn

Digital Signature

Victoria L. Klahn

Name (Typed)

04/01/20

Date