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Effects of Student Ontological Position on Cognition of Human Origins

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EFFECTS OF STUDENT ONTOLOGICAL POSITION ON COGNITION OF HUMAN ORIGINS

DISSERTATION

Presented in Partial Fulfillment of the Requirements for

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By

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ABSTRACT

In this study, the narratives from a hermeneutical dialectic cycle of three high school students were analyzed to understand the influences of ontological position on the learning of human origins. The interpretation of the narratives provides the reader an opportunity to consider the learning process from the perspective of worldview and conceptual change theories. Questions guiding this research include: *Within a context of a worldview, what is the range of ontological positions among a high school AP biology class? To what extent does ontological position influence the learning of scientific concepts about human origins? If a student's ontological position is contradictory to scientific explanation of human origins, how will learning strategies and motivations change?*

All consenting students in an AP biology class were interviewed in order to select three students who represented three different ontological positions of a worldview: No Supernatural, Supernatural Without Impact, or Supernatural Impact. The issue of worldview is addressed at length in this work.

Consenting students had completed the graduation requirements in biology, but were taking an additional biology course in preparation for college. Enrollment in an AP biology course was assumed to indicate that the selected students have an understanding

of the concept of human origins at a comprehensive level, but not necessarily at an apprehension level, both being needed for conceptual change.

Examination of the narratives reveals that students may alternate between two ontological positions in order to account for inconsistencies within a situation. This relativity enables the range of ontological positions to vary depending on concepts being considered.

Not all Supernatural Impact positions conflict with biological understanding of human origins due to the ability of some to create a dichotomy between religion and school. Any comprehended concepts within this dichotomy lead to plagiaristic knowledge rather than conceptual change. When conflicts occur, students employ alternate learning strategies for comprehension, but not apprehension, which result in plagiaristic knowledge.

These findings suggest that teachers consider the ontological positions of student worldviews because of the potential influence on knowledge construction and conceptual change, especially about topics involving the theory of evolution.

DEDICATION

I dedicate this work to my wife, Amy, my children, A.J. and Danielle, and to my Savior, Jesus Christ. Without any aspect of each, I could not have attained this lifelong goal.

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I am truly grateful to my wife for her patience, sacrificial love, and overwhelming support for me as I worked to realize my dream.

I also wish to thank my family, friends and church for the support to finish this venture and the assistance, when needed, even at their own expense.

Lastly, I thank the school and participants of this study. Without their support, I would not have had such an incredible opportunity for personal and professional growth.

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WORLDVIEW is an explanation and interpretation of the world and an application of this view to life. (See p. 5 for further details)

CONCEPTUAL CHANGE occurs when both comprehension and apprehension of a concept occur. (See p. 7 for further details)

COMPREHENSION occurs when learners actively construct or reconstruct meaning in order to integrate new knowledge already in their cognitive structure. (See p. 7 for further details)

APPREHENSION occurs when learners agree with or believes in comprehended knowledge. (See p. 8 for further details)

PLAGIARISTIC KNOWLEDGE occurs when comprehended knowledge is not apprehended. The newly assimilated or accommodated schema is weakly connected to the rest of the conceptual framework by being placed in a separate framework that may only be functional for recall and other lower levels of thinking. (See p. 8 for further details)

CHAPTER 1

INTRODUCTION

Statements of Science Students

We didn't feel like we need to get into a discussion about [human evolution]. We always get into arguments.

The teachers try to stay away from evolution, because it is so controversial.

We don't really talk about [human evolution], but there is a contradiction between what it says in the Bible and what people actually think.

When they talk about evolution, I disagree with it.

But how they say the world was created over billions of years ago, and how they say we came from evolution just makes me mad, but nothing else in science does.

They think people just make [human evolution] up. Nobody really knows. Nobody really knows what went on. We get into a lot of heated arguments about who is right and wrong.

It depends on how you were taught. No one really knows, and that's what science is all about, finding out. I think [human evolution] conflicts [with what I believe], because I already have one belief, like I grew up thinking there is a God. But [human evolution] conflicts with everything I ever thought. Nobody wants to think that what he or she really believes isn't true.

The preceding statements were expressed by students in this study who were taking an advanced placement (AP) biology class. They typify some common concerns that arise when students are confronted with ideas about human origins based on concepts associated with the theory of evolution.

I have always been interested in the arguments between creationists and evolutionists. One sure way to invoke a heated discussion between individuals that have differing positions is to ask a question such as, "What is the origin of the human eye?" The amount of emotion generated by topics of evolution has always fascinated me. The emotionalism became very evident to me when I took a graduate course entitled Creation and Evolution: Differing World Views. The course was a philosophical and historical survey of the controversy over evolutionary theory and creationist viewpoints. After a guest lecturer discussed the position of young earth creationism, I talked with a student who doubted that any scientist would believe in such a theory. The student said, "There is so much information that supports the theory of evolution that you would have to be completely blind to disregard thousands of research investigations." I asked the student if the lecturer held to the young earth creationist view because of the lack of information or because of ignorance. The student's response was, "probably lack of information." I then asked the student, "Do you think that if you presented *all* the data that supports the theory of evolution to the lecturer that he would change his belief?" The student's response was, "Probably not, because he already believes that it could not have happened the way that the data suggest," he replied.

This conversation delineates the creation/evolution controversy. Despite data, conviction weighs in more heavily; if one does not have a specific belief in either

creation or evolution, then the probability of controversy is decreased. If one believes that there is no supernatural force or being that exists, then why try to accept the ideas of creationism? This is not to say that one's response to a question about the existence of a supernatural force or being necessitates a belief in evolution or creationism, but rather that it is one of numerous aspects of a person's belief system that comes into play when considering questions of origins.

The purpose of this research is to investigate the effects that student worldviews have on learning scientific concepts regarding human origins. If one's worldview dictates what is perceived as true, then perhaps it also plays a part in understanding the theory of evolution. Could an examination of worldviews provide insight into why some AP biology students make statements like those presented at the beginning of this introduction?

Statement of the Problem

Once state teaching standards become aligned with national science education standards, a student will regularly be confronted with concepts of evolution before his or her graduation from high school (American Association for the Advancement of Science, 1993; National Association of Biology Teachers, 1996; National Science Teachers Association, 1996). Within any given classroom there are various worldviews and religious beliefs as well as a range of various views about the natural world (Cobern, 2000). Students who hold nonscientific beliefs for origins demonstrate less ability to use scientific reasoning when solving problems associated with the theory of evolution (Lawson, 1990). This study investigates: *Within a context of a worldview, what is the*

range of ontological positions among a high school AP biology class? To what extent does ontological position influence the learning of scientific concepts about human origins? If a student's ontological position is contradictory to scientific explanation of human origins, how will learning strategies and motivations change?

Rationale for the Study

Controversies regarding origins, whether by means of natural processes, supernatural guidance, or a combination of both, have given rise to numerous articles and books (Abney, 1997; Armstrong, 1997; Behe, 1996; Earley, 1998; Gish, 1995; Griffin, 1998; Johnson, 1995; Kitchner, 1982; National Academy of Sciences, 1999; Ross, 1999; Sinclair & Pendarvis, 1998; Zimmer, 2001). Public controversy over this topic is evident when considering the teaching of origins in schools (Meadows, Doster, & Jackson, 2000; National Academy of Sciences, 1998; National Association of Biology Teachers, 1996; Scharmann, 1994; Scharmann & Harris, 1992; Sinclair & Pendarvis, 1998). The teaching of evolution and the public controversy between evolution and creation provides the context for this study.

It is widely accepted by science educators that constructivism is the most fruitful view of learning (Steffe & Gale, 1995). The constructivist learning paradigm is based on the assumption that individuals construct meaning and understanding through multiple, familiar representations (i.e., experiences, culture, parents, media, teachers) (Guba & Lincoln, 1994). However, this individualized construction of meaning is influenced by students' worldviews (Armstrong, 1997). A person's worldview is the way he or she views reality based on numerous attributes (i.e., experiences, beliefs systems). The

philosophical foundation of a person's worldview rests on his or her ontological position, a set of beliefs that define reality or truth. The purpose of this study is to shed light on how differing ontological positions of student worldviews affect the learning of the concepts relating to human origins by means of evolution.

Definition of Terms

Worldview

If worldviews have an impact on the way that students conceptualize scientific topics, then teachers need to know more about student worldviews. Cobern (1989) explains that a worldview is a "fundamental, epistemological macrostructure, which forms the basis for [a person's] view of reality" (p 4). Phillips and Brown (1996) state that, "A worldview is, first of all, an explanation and interpretation of the world and second, an application of this view to life" (p 29). Therefore, a worldview comprises a person's ontological and epistemological position. Three major features (Supernatural, Humanity and Nature) must be examined in order to understand a person's worldview (Table 1-1) (Phillips & Brown, 1996).

Supernatural The Concept of Ultimate Reality or Truth	Humanity The Reality of Human Existence & Self-consciousness	Nature The Existence and Purpose of the World Around
• Does a supernatural force or being exist? • What impact does a supernatural force or being have on my life? • What impact does a supernatural force or being have on the natural world?	• Why am I living? • Why do I exist? • How must I live?	• How am I related to the physical universe? • Is the natural world friendly, hostile, or indifferent to man? • Is there a realm of reality that cannot be seen with physical eyes, but that is not supernatural? • Are there nonhuman personal beings that populate the universe?

Table 1.1: Sample Questions within a Worldview (Phillips & Brown, 1996)

One's worldview will influence the way one makes decisions and constructs meaning (Cobern, 2000). To illustrate how worldviews might come into play in a science classroom, I offer a contrived situation that highlights the ontological component of a student's worldview to indicate the potential implications for a teacher. A student's ontological position is determined by his or her view of reality or truth. Some examples of ontological questions are as follows: Is reality only what you can experience through your senses? Is there something real beyond this natural world? Is there a supernatural force or being that provides truth?

Contrived Situation

Students are given an essay question on a homework assignment that prompts them to explain how the numerous rock layers of the Grand Canyon were formed and exposed. Students A & B, for example, may suggest that the Colorado River has etched its way through the land, and has exposed the numerous rock layers that has taken several millions years to be deposited in this sequential pattern. In contrast, Student C may suggest that the sequential pattern of rock layers were deposited in a very short period of time by the Colorado River, which once was a major drainage system after the universal flood only a few thousand years ago.

How is it possible that students could consider the same question and derive two extremely different, apparently opposite, conclusions? One explanation is that they have different ontological positions. A student's thoughts about the formation of the Grand Canyon do not necessarily dictate his or her specific ontological positions. However, student A and B seems to have a presupposition that natural processes are adequate to explain natural phenomena and then also extrapolate ideas to explain what has occurred in the past or will occur in the future. Even though these two students responded similarly, they may have different ontological positions. Student A may hold a "No Supernatural" ontological position, which includes the view that nature is all that is or ever was or ever will be and there is no supernatural force or being. Student B may have a "Supernatural Without Impact" position that accepts the possibility or the existence of a supernatural power, but that the force in question does not engage or supersede natural processes. Student C may hold a "Supernatural Impact" presupposition that natural processes can help explain and predict the natural phenomena that are observable today,

but natural processes alone do not explain everything that has occurred in the past or will continue to occur in the future because there is a supernatural force that may supersede natural processes. The students' worldviews influence their thought processes as they interpret observations of the natural world and explain possible causes of observed phenomena.

Conceptual Change

In order for conceptual change, comprehension and apprehension of a concept must occur (Cobern, 1996). Comprehension occurs when learners actively construct or reconstruct meaning in order to integrate new knowledge with knowledge already in their cognitive structure (Driver & Scanlon, 1989). According to Piaget's theory of cognitive development, the integration process may involve assimilation or accommodation. Assimilation occurs when new knowledge is integrated into an existing schema within a construct. If assimilation of the new knowledge is not possible, then a learner must accommodate the new knowledge by either creating a new schema or modifying an existing schema (Wadsworth, 1971).

When a learner agrees with or believes in this new knowledge, then the learner will apprehend the new knowledge. Apprehension of new knowledge will lead to conceptual change by creating connections between newly comprehended schema and that of the rest of the conceptual framework of the learner. Therefore, conceptual change is often demonstrated with the ability to effectively reason or solve problems within that concept (Cobern, 1996).

Plagiaristic Knowledge

Plagiaristic knowledge is a term used here to denote knowledge that is comprehended but not apprehended, a situation that occurs when a learner does not agree with or believe in a newly comprehended schema. If apprehension is not achieved, then a newly assimilated or accommodated schema is not integrated within the rest of the conceptual framework, but rather is placed in a separate framework that may only be functional for recall. Recalling plagiaristic knowledge involves only lower levels of cognition since the plagiaristic knowledge is not integrated with the entire conceptual framework of the learner. Therefore, plagiaristic knowledge is often demonstrated by a person's inability to effectively reason or solve problems relating to particular concepts. Since plagiaristic knowledge is understood but not internalized, it is represented as personal knowledge but actually it is someone else's knowledge, hence the label, "plagiaristic knowledge."

Ontological Positions

The three ontological positions (i.e., No Supernatural, Supernatural Without Impact, and Supernatural Impact) described in the contrived situation are the primary focus of this research. Because of the complexity of ontological positions, it is necessary within this study to simplify the ontological positions into these three categories (Table 1-2). There may be blending of these ontological positions or there may be additional positions. For instance, a spiritualistic ontology (e.g., transcendentalism, pantheism, animism) may recognize an impersonal supernatural force or being within all things, but may perceive such an entity to have direct impact on natural process (Phillips & Brown,

1996). The manifestation of this position will be similar to that of the Supernatural Without Impact ontology, which is describe later, and therefore will not be specifically investigated in this study.

No Supernatural Ontology

The *No Supernatural* ontological position states that no supernatural force or being exists and only the physical, natural world makes up reality. The word naturalistic has more implications than just an ontological one, so it will not be used as a label within this study. For example, the use of naturalistic in the way that knowledge or truth is obtained or gained (i.e., epistemological perspective) may be a part of all three ontological positions. Any scientific investigation uses the tenants of epistemological naturalism, which involves use of the senses in describing the natural process observed through experimentation. When the word naturalism is used in this paper, it is referring to the ontological perspective (labeled as No Supernatural), which expresses the ideas that nothing exists beyond what may be empirically studied. All that is real is forthcoming from the sense experience; there are no innate ideas or indubitable propositions given by a supernatural being or force. When the word naturalistic or empirical is used, it will refer to the epistemological naturalism.

Supernatural Without Impact Ontology

Supernatural Without Impact ontology represents the idea that there may be or there is a supernatural being or force beyond our natural world, but that force or being has no impact on our world today, and that all natural phenomena today can be explained by natural processes. Therefore there is or may be something beyond our natural world,

but all that is real or true about the material world may be known through empirical investigations.

Supernatural Impact Ontology

Supernatural Impact ontology expresses the idea that there is a personal, supernatural being or force beyond our world, and that being or force has the ability to have direct impact on our world, which could occur in contemporary time as well as in the past. There is reality beyond our natural world that transcends life. Truth exists through both empirical investigations and supernatural interventions (i.e., dreams, mystical insight, inspired writings).

	Supernatural Existence	**Supernatural Impact on Nature**	**Supernatural Impact on Knowledge**
NO SUPERNATURAL	Supernatural force or being **DOES NOT EXIST**.	There is no supernatural; therefore there is **NO IMPACT**.	There is **NO** supernatural **IMPACT**; must rely on empirical investigations for knowledge.
SUPERNATURAL WITHOUT IMPACT	Man **CANNOT/DOES NOT KNOW** if a supernatural force or being exists, but there could be. **OR** Supernatural force or being **DOES EXIST**.	There is no way of knowing or investigating supernatural impact, therefore there is **NO IMPACT**.	There is **NO** supernatural **IMPACT**; must rely on empirical investigations for knowledge.
SUPERNATURAL IMPACT	Supernatural force or being **DOES EXIST**.	Supernatural has **AS MUCH IMPACT** as necessary in past and contemporary times.	There is supernatural **IMPACT** that may provide insight beyond or explanation to empirical data.

Table 1.2: Comparison of Ontological Positions

Limitations of the Study

This study examines students' learning of human origins through the process of evolution given their various ontological positions that form the foundation of their worldview. It does not examine brain research and its impact on learning. Nor does it investigate how knowledge is stored or recalled by means of neurological impulses.

Also, this study will not delve into the debate between evolution and creation or any of its sidebars. Therefore, no discussion will be presented whether or not alternative theories of origins should be presented in the science classroom, or whether alternative views actually constitute scientific theories.

CHAPTER 2

REVIEW OF LITERATURE

Theoretical Underpinnings

This study is based on the assumption that a student's worldview influences how he or she constructs his or her conceptual framework when learning. Since learning is an individual process stemming from multiple experiences, observations, and reflections, the worldview of a student will influence his or her understanding (Gore, 1985; Kagan, 1986; Lawson, 1990). While there are many influences on students' understanding, this study will focus on the influence of the ontological positions. Information, experiences, or observations that conflict with a student's worldview may be ignored or become plagiaristic knowledge that is stored. This principle provides insight to teachers in light of conceptual change theory. Changing misconceptions that have been apprehended is a challenge to educators in science (Posner, Strike, Hewson, & Gertzog, 1982).

According to Cobern (1991), there is an assumption in the science education discourse community that students have a relatively homogeneous, fundamental view of the natural world. This assumption implies that students are able to assimilate and value scientific understanding when scientific concepts are presented. Cobern argues it is a mistake to make this assumption, and that doing so will only hinder the likelihood of conceptual change occurring. When applying conceptual change and worldview theories,

teachers should be aware of each student's worldview, helping them recognize that ideas held by a student may restrict the student from gaining complete conceptual understanding of science topics (Lawson, 1991).

Each student uses his or her worldview (Figure 2-1) as a lens to consider external stimuli that is cognitively assimilated or accommodated according to Piaget's theory of cognitive development (Wadsworth, 1971). Comprehension may occur in which each student cognitively stores the data for a purpose (i.e., the next quiz or test or presentation). Some may go beyond the comprehension level to the apprehension level by taking possession of the concept (i.e., agreement or belief in the concept) (Cobern, 1996). If apprehension does not occur, then the comprehended concept is understood only by means of outside sources and never internalized. This form of comprehension is referred to as *plagiaristic knowledge* since the individual has understanding of the concept without it being part of their construct. When an individual has knowledge that they do not believe in, and does not claim any ownership of it, then that knowledge is plagiaristic.

Most of the scientific concepts that high school students comprehend will also be apprehended. For example, most students will believe and agree with the concepts of life cycles of plants. Therefore, once comprehension occurs apprehension will follow. However, when considering the concepts of the theory of evolution, the likelihood of apprehension drastically changes mainly due to preexisting personal beliefs held by the student. Possibly no other topic in science possesses a greater lack of apprehension in students than the theory of evolution. Therefore, many students have plagiaristic

knowledge of the theory of evolution, in that they could show levels of understanding in an assessment, but do not accept it as being true.

A student's worldview becomes the mechanism that filters the constructed understanding from comprehension to apprehension, ultimately allowing for conceptual change to occur (Cobern, 1996; Posner et al., 1982). The comprehended concept must be apprehended in order for conceptual change to occur. Plagiaristic knowledge may contort the ability of a teacher to assess the student's conceptual framework. If students construct their own meanings, and if a teacher seeks conceptual change, then it becomes imperative to consider each student's worldview when teaching. If a conceptual understanding for a scientific concept is the goal, then a teacher must consider the major aspects of a learner's worldview.

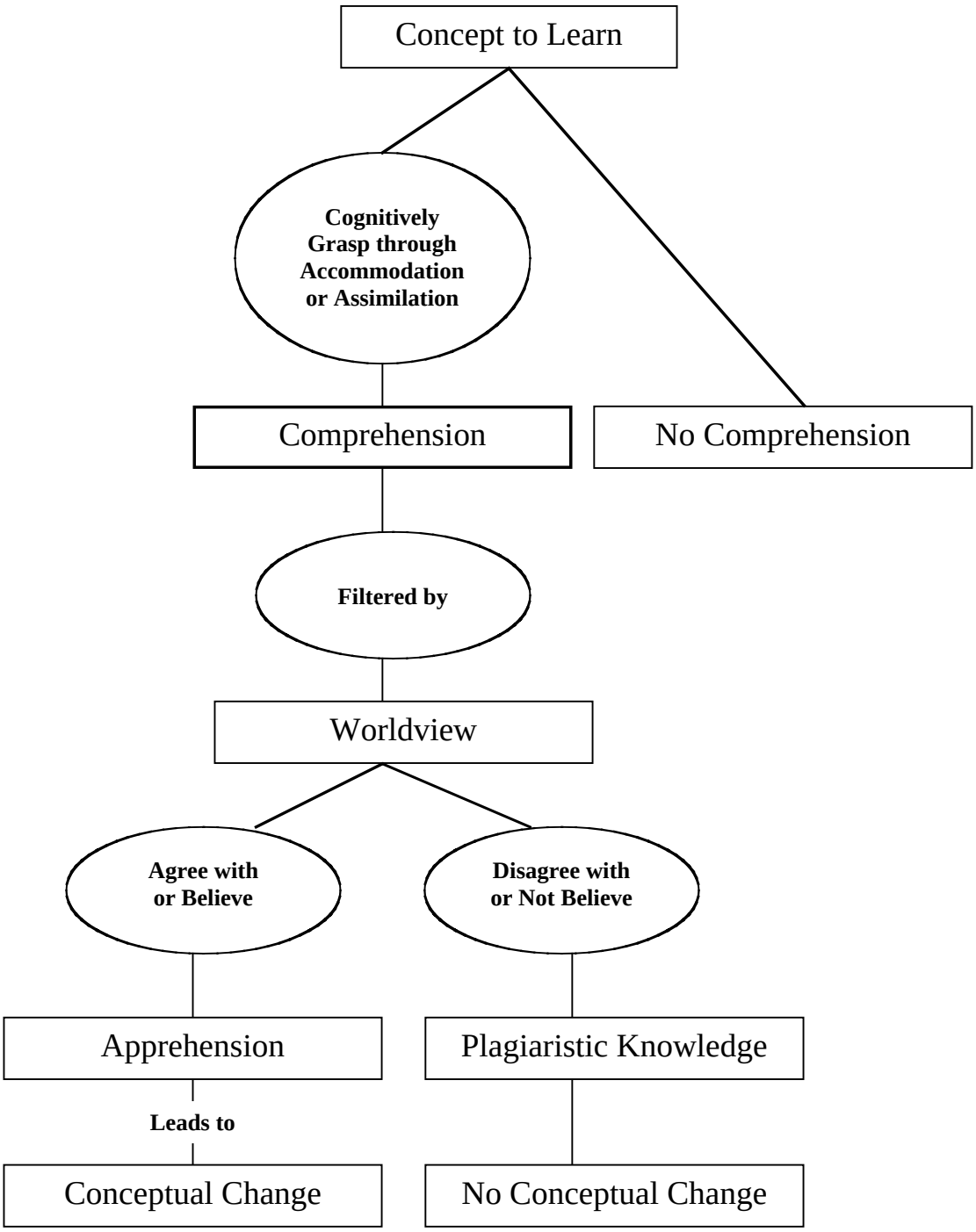

Figure 2.1: Plagiaristic Knowledge Model (Modified from Cobern, 1996)

Cognition and Education

Throughout the centuries, educators have strived to answer the question, "How do children learn?" Each teacher's decision about teaching methods, strategies, and content should be in alignment with his or her response to this question. The behaviorist approach of how children learn dominated the practice of education for nearly a century. Baddeley's model suggested that if the neuro-impulse was strong enough in the short-term memory that it would be imbedded in long-term memory, which could then be recalled at a later time (Baddeley & Dale, 1966). This led to educators making students recite facts, "solve" the same math problem numerous times, and listen to lectures about the content. Students would take notes and then memorize for the exams. Even though the behaviorist's approach provided some students with the ability to recall facts and "solve" certain math problems, it lacked the necessary mechanisms to allow the students to make connections and think critically.

Eventually, Baddeley's model was revised to suggest that short-term memory is composed of multiple memories that include the senses, emotions, physical movements, and episodes of past experiences that either individually or in concert can produce long-term memory (Amos, 2000; Hopfinger, Buonocore, & Mangun, 2000). Furthermore, researchers began to hypothesize that conceptual knowledge was not found in one specific region of the brain, but rather was located in multiple areas. For example, one does not store the meaning of a "cup" in a Webster-type definition in one location of the brain. The concept of a "cup" is derived from several means: past experiences of holding and smelling a cup of hot chocolate, buying a coffee cup for your favorite teacher in school, and seeing multiple shapes, styles and materials that are all referred to as "cups."

One is not able to categorize a cup from a single definition or several pictures, but rather through interaction with the object. If the concept of a cup is so complex, consider the complexity of a scientific concept. Conceptual knowledge is based on meaning that is formed through one's experiences and cognitive ability. Each individual forms concepts throughout his or her life. This understanding has given rise to the current educational learning paradigm of constructivism (Good, Wandersee, & St. Julien, 1993).

Foundation of Constructivism as a Theory of Cognition

The early years of education research began as the result of the separation of psychology from philosophy, which provided researchers with the ability to study the learning process based on brain research data. From notable researchers like G. Stanley Hall, William James, John Dewey, Edward Thorndike and Charles Judd, the science of education began to blossom, providing several learning theories (Lagemann, 2000). New developing techniques of statistical analysis provided Thorndike the ability to quantify the educational process through standardized test and I.Q. tests. The scientific community began to recognize his educational research paving the way for future educational researchers to perform more research that is less quantified. Dewey demonstrated the educational process as an adaptive construction of knowledge through the community of learners. The learner's everyday experiences, interests, and instincts would be the starting point for education (Dewey, 1938). Piaget's cognitive-developmental theory suggested that cognitive development takes place in stages as the learner manipulates and explores his or her world, which provides reasons for hands-on activity and discovery learning (Oja, 1990). Also, Vygotsky's sociocultural theory explained that learning occurs in a scaffolding manner through proper guidance in which

the “zone of proximal development” increased as other peers or teachers share in the learning experience so that a group would be able to handle and understand concepts that would be beyond each individual (Hausfather, 1996). The contribution of Dewey, Piaget, and Vygotsky provided some of the framework for the constructivist’s theory of learning (Tomlinson, 1997).

Constructivism

Essentially, constructivism means that each individual will actively construct and reconstruct his or her own knowledge, meaning, and understanding from their experiences, observations, thoughts and feelings (Brooks & Brooks, 1999; Hausfather, 2001). Each student will learn in a different way based upon his or her own constructs. The implication is that teachers will no longer force a child to learn by making them recite, memorize or repeat, but instead invite a child to learn by providing a positive learning environment, allowing students to succeed, creating interesting and practical problems to solve, and allowing beneficial social interactions and experiences to gain insight from others. This, it is hypothesized, will empower the student to draw from the wealth of past and current knowledge to comprehend the concepts in order to build to their conceptual framework.

Culturally Sensitive Pedagogy

Constructivist theory leads us to consider the aspects of how an individual learns. According to Wiggins and McTighe (1998), understanding is not a linear process, but a multi-tiered process that includes six facets: explanation, interpretation, application, perspective (critical and insightful points of view), empathy, and self-knowledge. (The latter three would not be found in the learning theory of a behaviorist, but adds the

necessary elements to consider when looking at the child as a whole.) The teacher needs to get to know the learner as an individual in his or her cultural contexts in order to potentially create a successful learning environment (Nieto, 1999). A culturally diverse classroom requires the teacher to include culturally sensitive pedagogy to enhance the opportunity for not only academic success, but also for purpose and meaning in personal development (Chisholm, 1994).

Making connections with students is not limited by the lack of knowledge or understanding of the student.

> We must begin to realize that it is not the experiences, or lack thereof, students bring to the classroom that pose our greatest challenges; it is how we perceive and value these experiences as potential connectors for new learning and what we do with them as a starting point for more teaching and learning to take place. We must help teachers begin to see the experiences of students as valid and valuable connectors to bridge the gap between what students already know and what we want them to learn. These connectors, which we have for so long refused to acknowledge, are needed for more successful learning opportunities to become normal, everyday occurrences in all classrooms (Thomas, 1998, p. 152).

Understanding and considering the culture of the learner and the cultural differences within the classroom is more than just considering the ethnicities (Banks & Banks, 1995). Other factors that should be considered are learning styles (Du & Simpson, 2002; Fritz, 2002; Tsuchida, 2002), communication modes (Irvine, 1990), student motivation (Wlodkowski & Ginsberg, 1995), belief system (Greenstein &

Greenstein), spirituality (Miller, 2000), and worldview (Cobern, 1989). This holistic approach needs more attention in science teaching.

Worldview and Science Education

It becomes necessary for teachers to consider the learner's worldview as one of many factors when trying to have a culturally sensitive pedagogy. Building on the research of culturally sensitive pedagogy and following Cobern and Lawson, I argue that a science teacher must be aware of students' worldviews, and must recognize that ideas held by students may keep them from achieving conceptual understanding of science topics (Lawson, 1991). "Worldview provides a non rational foundation for thought, emotion, and behavior. Worldview provides a person with presuppositions about what the world is really like and what constitutes valid and important knowledge about the world" (Cobern, 1996, p. 584). Therefore, a person's worldview will help form conceptual knowledge about natural phenomena, whether or not those concepts are misconceptions (Arendt, 1978).

Cobern (1996) describes the difference between thinking and comprehension, and knowing and apprehension (Figure 2.2). Thinking may produce the ability to grasp a scientific concept (comprehension), but to result in conceptual change, comprehension must produce apprehension, which operates through knowing and taking possession of the scientific concept. Possession occurs when the concept corresponds with one's worldview.

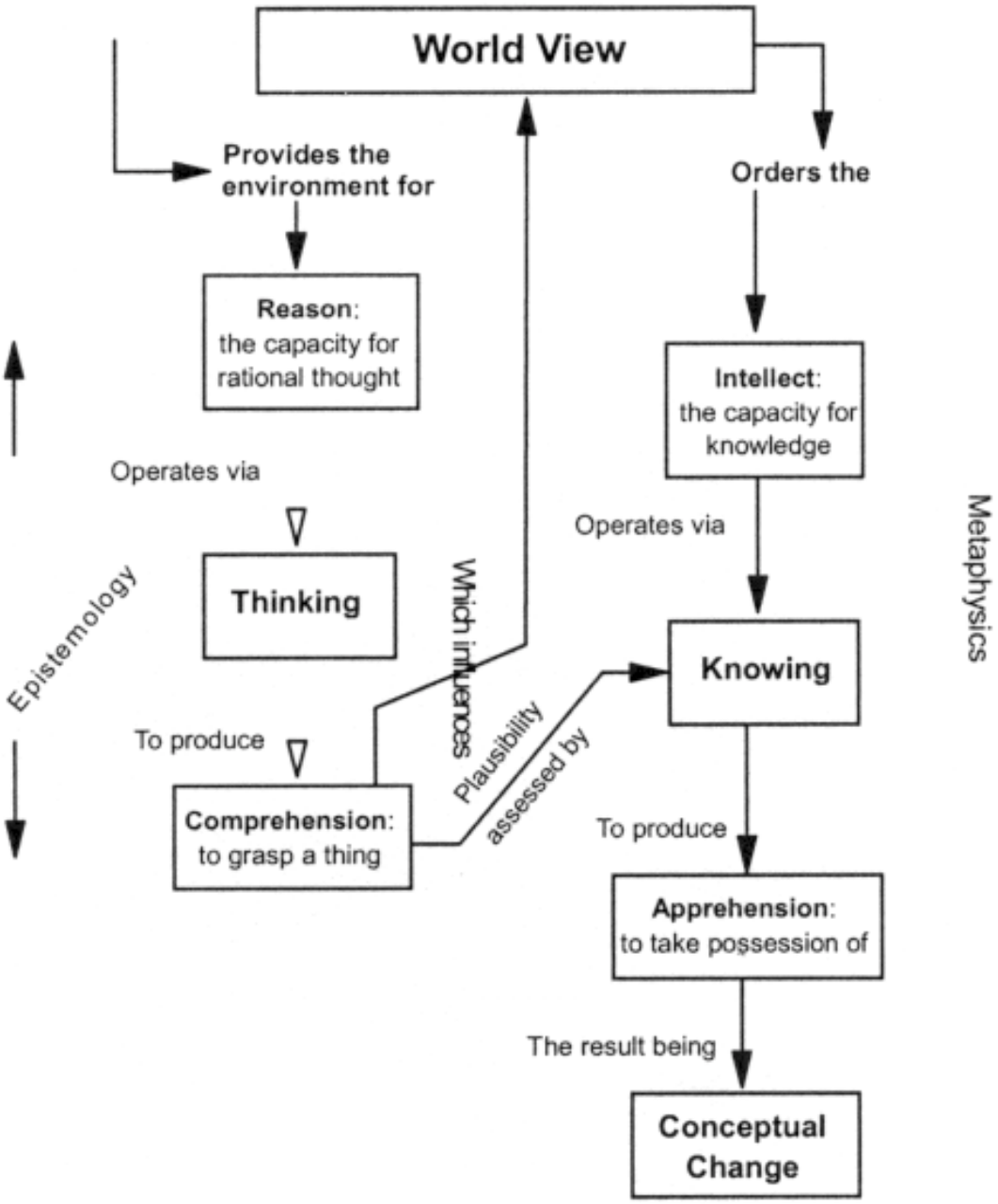

Figure 2.2: Worldview and Conceptual Change (Cobern, 1996)

One of the most obvious areas in science education in which dichotomy appears between comprehension and apprehension is in the teaching of origins. In 1995, the National Association of Biology Teachers (National Association of Biology Teachers, 1996) stated that all life is the outcome of "an unsupervised, impersonal, unpredictable, and natural process (p. 61)." The National Science Standards (National Research Council, 1996) and the Benchmarks for Science for all Americans (Rutherford, 1990) state that the concept of origins is to be taught as natural process. The question that arises is, "How do students with an ontological position of Supernatural Impact respond to learning empirical explanations of human origins?"

Brain research (previously mentioned) provides the physiological foundation for how conceptual memory is stored (Coirier, 2002). Cobern's worldview and conceptual change model in 1996 has made it imperative for teachers to see students as separate learners who are framing their own constructs of reality which will ultimately be apprehended by a student as long as it coincides with their worldview. Conceptual change in these areas will theoretically take place only if the student can accommodate or assimilate their worldview.

In this study, I propose considering the work done by Lawson and Thompson (1988), which determined that nonscientific beliefs hindered student ability to learn scientific concepts by investigating students who apparently have an ability to learn scientific concepts (i.e., AP Biology student) even though they may hold nonscientific beliefs (i.e., ontological position of Supernatural Impact). Fysh & Lucas (1998) found that high school students' worldviews are more sophisticated than most teachers realize, and that the students did not have conflict with their religious beliefs and the teaching of

evolution. The proposed research will investigate the influence of a student's ontological position on the learning of scientific concepts.

CHAPTER 3

METHODOLOGY

A mixed methodology, incorporating both qualitative and quantitative research techniques, has been used to examine the core questions of this study. Thought quantitative data were gathered and interpreted, a strictly quantitative approach was deemed inadequate for providing insight into students' formation of concepts, which will be explained later in more detail. Consequently, qualitative methods were employed to provide deeper, contextual responses to the research questions.

Constructivist Research Paradigm

My research questions seem best answered from a relativist perspective. A relativist perspective is one in which each student participant constructs his or her own reality based on a conceptualization which is different and relative for each individual (Brooks & Brooks, 1999; Guba & Lincoln, 1994; Phillips, 2000; Steffe & Gale, 1995). Students' conceptualizations in science are based on their observation of scientific phenomena (Renner & Marek, 1990), understanding of scientific concepts (Adey, 1999), experience with scientific principles (Shapiro, 1994), metaknowledge of science (Driver & Bell, 1986), view of learning (Fritz, 2002), and attitudes (Osborne, Driver, & Simon, 1998). Therefore, a study that investigates the students' conceptualizations is best

understood from an inductive, relativist's perspective (Abell & Eichinger, 1998; Duit, 1995).

A positivist's research paradigm would require the researcher's ontological and epistemological perspective to rely on a "knowable" truth that is the fundamental nature of the world (i.e., reality) for everyone, obtained through our senses using of logic and scientific inquiries (Abell & Eichinger, 1998). The purpose of a scientific inquiry is to explain some phenomenon so that one can either predict or control that phenomenon in the future. This explanation would be knowledge that is derived from hypothesis verified through the inquiry to produce facts or laws.

Biases will not affect the findings as long as all the guidelines and procedures are followed correctly (Guba & Lincoln, 1994; Habermas, 1989). The findings of this type of research are based on the idea that everyone forms concepts in the same way, and that a specific investigative tool will recognize this truth, which could be transferred across the study's population (Moschkovich & Brenner, 2000). For this reason, trying to quantify a student's learning process became a dubious task.

Credibility

When interpreting students' conceptions based on observations of students' reactions to a task or investigation of the verbal or written responses to a project, the researcher usually transforms verbal response into data. Making sense of student conceptualizations is influenced by the researcher's expectations and ideas. This means that the students' conceptualization data is derived only from the biases of the researcher, and not truly the students' own. In other words, what might be considered to be the

students' conceptualization is actually the researcher's conceptualization of the students' conceptualization. To reduce researcher influence in the interpretation process, a methodology might include a hermeneutical cycle (Duit, 1995), which is series of interviews that result in a narrative of the participant's ideas, which is edited and approved by the participant. The researcher's task is to analyze participant responses, yet remain as much as possible an objective portal, writing the story of the student without trying to influence responses. I accomplished this task by not making judgment statements about student responses and by using students' own words or examples when asking followup questions. Also, the narrative draft was generated solely from student responses. Each final draft was edited and corrected by the student to ensure that it reflected the student's words and not my interpretation of the student's words. My primary goal was not to pass judgment on the student, teacher(s), or school district in the study, but to generate description and understanding. To limit my biases in the data collection and interpretation, I used the student's own words and his or her approval of the final form of each narrative, which will be described in detail later (Duit, 1995).

Duit (1995) states, "It is of utmost importance that researchers and teachers are aware of [the hermeneutical cycle]." When investigating the phenomenon of understanding, qualitative inquiry methodology is essential (Schwandt, 1999). Examining the influences of a student's ontological position in the learning of human origins is best accounted for when the method is understood to be an inductive approach. This will allow the participant to express their position and perspective through meaningful conversations that occur during in-depth interviews and not the researcher's interpretation of the students' conceptualization. The primary method for gathering data

in this study was through the hermeneutic dialectic cycle (Boyles, 2000; Byrne, 1999; Guba & Lincoln, 1989; Rennie, 2000), which allowed me to interact with the student, constructing a narrative that is modified through a dialectic interchange. Through a series of meetings, the final narrative, which was approved by the student, has produced a far more credible and sophisticated narrative than what would have been produced using other methods (Guba & Lincoln, 1994; Spivey, 1995; Whan, 2001).

Generalizability

Science education research has shifted away from the positivist and post-positivist paradigms in order to acquire knowledge in areas that involve significant components aimed at knowing more about inquiry, teaching, and learning (Kelly & Lesh, 2000). So what is the concept of generalizability in a nonpositivist paradigm? Since one of the purposes of research is to allow communication of findings in order to build on or challenge current models or concepts, generalized research allows the building of models that apply in principle to settings beyond those that gave rise to the models originally. Generalizability in the constructivist paradigm is more interested in forming statements that are common between similar settings such as a science classroom. This assumes that human behavior is not random or idiosyncratic, which is the basis of all of the social sciences (Mouton & Marais, 1988; Seale, 1998; Spector & Glass, 1991). My concern is not with the aspect of whether my findings can be generalized for a population, but rather, has to do with which settings and subjects will my findings be transferable, and within that setting and population the findings have value (Gubrium & Holstein, 2000).

While my findings should not be generalized to other populations, they may be transferred and related to other individuals and populations.

Reliability

Will two researchers independently studying the same setting or subjects come up with the same findings? This is the usual question when considering reliability to quantitative investigations. The consistency in results of two different investigations made through a constructivist research paradigm is not necessarily a requirement for reliability (Heider, 1988). To ensure a reliable fit, the participants are active in the editing process of the final narrative, as well as giving approval that the narrative accurately depicts their thoughts. Also, I was concerned with the accuracy of data gathered by the self-declared biographical information. To ensure that this occurs without breaking the participant's right of privacy, I had the participating teacher check the students' answers with school records, and initial the form next to every accurate declaration, leaving blank the forms that provided inaccurate information.

Hermeneutical Dialectic Cycle

This case study employed a hermeneutical dialectic cycle to investigate the attitudes and ways of understanding and accepting theories of origin, which is best seen through meaningful conversations (Guba & Lincoln, 1989). Hermeneutics is an inductive approach focusing on the discovery of meaning inherent in language (McConnell, 1998; Rennie, 2000). The end product of hermeneutical inquiry is an interpretive account (a narrative), which provides the ability to capture the subtle,

complex, and contextual qualities that are unique to individual experience (McConnell, 1998; Whan, 2001). This method of textual analysis is an "artful" form of understanding and a process of exposing hidden meanings and concepts (Byrne, 1999). This methodology emphasizes an interpretation of language by situating the text and the interpreter in the participant's worldview underpinnings (Mkhize, 2000).

Textual analysis of the narrative can be achieved as I, as the researcher, go from a naïve understanding, a superficial insight of the entire text, to a deeper understanding, a meaningful insight into where the parts of the text are related to the whole and the whole to the parts (Geanellos, 2000). Through exposition of the concepts of distanciation, appropriation, explanation and understanding, guess, and validation, the hermeneutical dialectic cycle will provide textual analysis of the participant's narrative (Geanellos, 2000; Kezar, 2000; Whan, 2001). Employing hermeneutics with the participants involved them in the construction of meaning around their ideas, which are generated from within their experiences, intellectually interpreting the information by their language (Boyles, 2000). Understanding of the narrative is unfolded by learning rather than reading the text, which requires openness, dialogue, listening, and considering the possibility for misunderstanding (Schwandt, 1999).

This study uses the qualitative methodology of interviews and the hermeneutical dialectic cycle to investigate what role the ontological position of a science student's worldview has on the learning of human origins by means of the theory of evolution. All consenting students in an AP biology class were interviewed to select three participants to participate in the hermeneutical dialectic cycle. The next chapter will explain this selection process. These participants produced and edited a narrative, which was later

interpreted to determine the influence of one's ontological position on science learning. Chapter 5 explains the findings from the hermeneutical dialectic cycle.

Interpretation of Narrative

In the constructivistic methodology, it would not be permissible to have a view of singularism, which states that there must be one and only one admissible interpretation of the narratives. If hermeneutics required a singularistic view on interpretations, it would stop the development of models of understanding (See Geanellos, 1998), and would be a direct contradiction to the methodology itself. Therefore, multiplism, which is states that there may be more than one admissible interpretation, is the view in which this study will hold to during this process.

Even with the nature of interpretation being multiplistic, I will explain what my understanding of the text is at this point in time, realizing that it could never be complete and may change with further investigations, because my preunderstandings (i.e., ideological perspectives, knowledge) have a significant impact on this process (Wiklund, Lindholm, & Lindstroem, 2002). But it is important to remember that the interpretation that I will present can faithfully represent the narrative by providing every opportunity to reveal its truths (Geanellos, 2000). My goal for my analysis of the narratives will be to account effectively for my understanding of it at this time. For each of the participants, the textual analysis the narrative will pass through an understanding that is naïve to one of depth.

First Pilot Study

The first pilot study included two questionnaires meant to provide insight into how students learned the concepts of the theory of evolution with respect to his or her worldview. Questionnaire 1, Assessing Beliefs, used by Lawson and Weser (1990), and Questionnaire 2, selected questions from the Views of Science-Technology Society (VOSTS) questionnaire, used by Aikenhead, Alan, and Fleming (1989), was given to volunteering high school students during several different study halls. These questionnaires were unchanged from the actual research articles in which they were obtained except for these additional questions to the end of each questionnaire, "Which question(s) (if any) did you not understand? Why?" and "Which question(s) (if any) would you change? How would you write it?" To questionnaire 2, I added, "Does science and religion contradict? Explain why or why not?"

Purpose of the First Pilot Study

The purpose of the first pilot study was to determine a suitable age for participants in my research, to investigate the understandability of the questionnaire, and to gain insight into any conflict between science and religion. The overall score of the first questionnaire determined the extent to which students have beliefs in creation or evolution as part of their worldview. These scores were then compared to the VOSTS questionnaire, which provided information about the degree to which these worldviews influenced the acceptance of scientific or nonscientific theories of origins.

Adjustments from the First Pilot Study

Appropriate Age

There were a total of 25 students in the five age groups: 14 or under, 15, 16, 17, 18 or older, which had 4, 6, 7, 4, 4 students respectively in those groups. Questionnaire 1 provided the option of an "I Don't Know," which provided me insight into whether the participant could make a decision for the specific question. The following percentages of "I Don't Know" for each age group is as follows: 14 – (26/92) = 28%, 15 (37/138) = 27%, 16 (32/161) = 20%, 17 (20/92) = 22%, 18+ (21/391) = 23%. From these percentages it appears that all of these age groups had similar problems deciding on an answer. Even when making two collective groups of 16 or under (95/391) = 24%, and 17 or older (41/184) = 22%, there appeared to be no difference. However, due to the open-ended question at the end of the questionnaire, I found that the older age group responded with the "I Don't Know" response due to the wording, and by changing the wording to their recommendation, then he or she would respond other than "I Don't Know," by the rate of 5 explanations for 16 or under age group and 25 explanations for 17 or older age group. Once I eliminated all of the "I Don't Know" responses from the participants' responses who either expressed why they chose that response or reworded the question in order to pick a different option, I found these percentages: 16 or under (90/391) = 23% and 17 or older (16/184) = 9%.

On questionnaire 2 there was not the issue of an "I Don't Know" response, but the comparison of responses to the open-ended question of, "Does science and religion contradict? Explain why or why not?" was incredible. The typical response to this question for the 16 or under group was a few words (16.3 words on average) compared to

the 17 or older group (80.7 words on average). The findings from these two pieces of data seemed to suggest that participants 16 years old or younger had more difficulty communicating in written response or deciding what he or she understood about his or her worldview and science. For these reasons it appeared to be an appropriate choice to investigate students that are 17 years old or older in my study.

Lack of Insight

Even though questionnaire 1 was used in past studies to determine a person's worldview, it did not determine the person's ontological position, which is necessary for the purpose of this investigation. Also, of all of the questions from questionnaire 2, the last open-ended question provided the best insight into what the person was thinking. It became apparent that if I wanted to understand how a person dealt with conflict in science or what influence does one's ontological position has on learning science, I must choose an alternative methodology.

Second Pilot Study

The second pilot study was an interview process that included 15 voluntary participants of ages 17 years old or older from the same public high school used in the final study, none of which participated in the first pilot study. The interview questions were as follows:

What makes up reality or truth for you?

Do you think that science and religion ever contradict? If so, how?

How did humans get here?

Did you ever have to learn something in a science class that you did not agree with? If so, what?

Purpose of Second Pilot Study

The purpose of the second pilot study was to improve the interview questions and my interview skills. I never purposefully tried to extract or clarify information about a person's ontological position, or his or her perspectives about science and religion. Nevertheless, I knew I would need to modify some questions and possibly the sequence of the questions. Also, the more practice I gained in asking questions and listening to the responses, the better I became at judging what question best follows during the interviewing/learning process (Kezar, 2000).

Adjustments from the Second Pilot Study

During the first interview I realized that the first question, "What makes up reality or truth for you?" was poorly stated because the participant did not understand the question well enough to even answer it. He was not the only student that could not respond to that first question. In fact, all 15 participants asked me to rephrase that question. So as I continually struggled to explain what I was trying to ask, I began to realize that the best question was "Do you believe that there is some supreme force or being that exists beyond our world? If so, how much impact can or does this supreme force or being have on our world?" When I asked in this manner, it no longer necessitated the students understanding the philosophical meaning of reality or truth.

The next change that needed to be made was on the third question, "How did humans get here?" Ten of the 15 participants thought that I was referring to how babies

are born or some aspect of the reproduction cycle. I had to change the question from referring to human origins to the origin of the Universe, earth and living things.

All of the participants had similar answers for the second question, "Do you think science and religion ever contradict? If so, how?" This led me to think I was setting the participant up to have contradiction because of question 1 being of the ontological perspective. It seemed that asking questions about beliefs in a supernatural being or force would best be moved to the end of the interview so as to not create a perception of an expected answers to future questions.

During the interview process I also asked 9 of the 15 participants how they would define science and what they would not consider science. The rationale for asking this question was based on several comments made by the participants. For example, one response to the second question, "Do you think that science and religion ever contradict? If so, how?" was, "No, because they are basically the same thing." I asked students to define science if they alluded to a commonality between science and religion (or any other non-science) or that science is everything. Because of this, I felt it necessary to include in the preliminary interview the question, "What is or is not science?"

Preliminary Interview

The range of ontological positions of student worldviews was interpreted primarily through the preliminary interview question #6 (Do you believe that there is some supreme force or being that exists beyond our world? If so, how much impact can or does this supreme force or being have on our world?). The following labels were given to each participant based on this response:

- **No Supernatural** ontology expresses the belief that there is no supernatural being or force beyond our world.
- **Supernatural Without Impact** ontology expresses the beliefs that there may be or there is a supernatural being or force beyond our world. However, that force or being has no impact on our natural world today, and all natural phenomena today can be explained by natural causes.
- **Supernatural Impact** ontology expresses the belief that there is a supernatural being or force beyond our world, and that being or force has the ability to directly impact our world, both in the present and in the past.

I created and defined these labels based on general ontological positions that were presented during my educational process and several philosophical readings (Abell & Eichinger, 1998; Clark, 1994; Cleminson, 1990; Connelly, 1996; Dagher & BouJaoude, 1997; Fysh & Lucas, 1998; Habermas, 1989; Klee, 1999; Lawson, 1992; Loving & Cobern, 2000; Phillips & Brown, 1996; Reich, 1997; Robbins, 1992; Rowe, 1995; Schommer & Walker, 1995; Shanahan, 1997; Stone, 1999).

CHAPTER 4

DATA COLLECTION

I had the impression from various national surveys that the majority of Americans believe in the existence of some supernatural force or being. So when I wrote the proposal for this study, I thought it might be difficult to identify a student in a public high school AP biology class who did not believe in the existence of a supernatural force or being (i.e., No Supernatural ontology). I never anticipated that it would be difficult to find a student who believed in the theory of evolution as the explanation of human origins, however, yet that is the situation I encountered when I proceeded with this study.

This chapter provides first a perspective of the school, and then an overview of the responses from participants selected for the final phase of this study will be made with general responses so as to justify the selections. Chapter 5 will include a discussion of the data and interpretations of the hermeneutical dialectic cycles for the three participants selected.

Overview of Study

Initial Meeting with Students

During the first meeting with the AP biology class, I explained to the students the nature of the study, the rewards that will be given for participation, and the procedure for

filling out the Parental Consent Form (Appendix A). I then handed out the consent form and the Information Form (Appendix A), and answered any initial questions. This scripted meeting (Appendix B) was held in the presence of the cooperating teacher.

Preliminary Interview

All interviews were audio taped, took place in a room that was designated and approved by the school's principal, and did not conflict with any academic class. At the beginning of the interview, each participant filled out a biographical form (Appendix C) with an attached nametag. After the data had been collected, and the cooperating teacher confirmed the responses as being accurate, the nametag was removed and discarded so that no connection between student names and data could be made. Upon completion of the biographical form, the participants were interviewed (Appendix D). The interview questions, a set of six questions that led into other questions based on the previous response, were as follows:

1. According to what you have learned in the science class, how did the Universe, earth, and living things come about?
2. According to what you believe is true, how did the Universe, earth, and living things come about?
3. Do you think that science and religion ever contradict? Explain why or why not?
4. What is science? What is not science?
5. Have you ever disagreed with something that is taught in your science class? If so, what would be the reason(s) for disagreeing with this information?

6. Do you believe that there is some supreme force or being that exists beyond our world? If so, how much impact can or does this supreme force or being had on our world?

Final Phase

After the preliminary interviews, three participants were chosen to participate in the final phase of the research. The selection process is described on page 48. This final phase utilized the hermeneutical dialectic cycle (Guba & Lincoln, 1989) as a means to allow students to expound on their answers to the preliminary interview questions and to verbalize their thought processes about learning.

Timeline

At the initial meeting, the AP biology students received the Parental Consent Form, and had two days to return it signed. On the third day following the initial meeting, the time and date for all of preliminary interviews were arranged. The preliminary interviews took three school days to complete. After completing these interviews, it required four days to examine all responses and to select the three participants for the final phase of the study. The length of time for the final phase, the hermeneutical dialectic cycle, was 15 school days.

Participants of the Study

The study involved students ranging from 18 to 19 years old, none of which participated in either of the two pilot studies, who were enrolled in a high school advanced placement (AP) biology class in a rural public high school. The demographic

make-up of the student body is similar to the demographics of a middle class, rural community of approximately 40,000 people: majority of European Americans, minority of African-American, and very few Asians and Hispanics. The public school is a Division 1 school, which is the largest division for this state, and graduates on average more than 250 students each year. Since the students were in an AP biology class, it was assumed that they have the ability to learn scientific concepts in biology and have previously studied evolution, given that the prerequisite requirements and the curriculum program of the school district are aligned with state science content standards. A Parental Consent Form (Appendix A) was given to each student in the AP biology class, and students were asked to return a completed form to the cooperating teacher. Only those that were given parental consent (83% of class members) participated in this research,. Half (8% overall) of the students that did not participate in the study returned the consent form with the parent's rejection of consent. The other half (8% overall) told the cooperating teacher that they had forgotten to take the form home, lost the form, or forgot to bring the signed form back.

Preliminary Interviews

There were two primary purposes for the preliminary interview process. The first was to investigate the range of ontological positions of a worldview among students in the science class. The second was to select participants for the final phase of the study based on the categories of No Supernatural, Supernatural Without Impact, or Supernatural Impact ontology. The general responses for the questions that were used to help select the three participants for the hermeneutical dialectic cycle are presented in this

section. These general responses will then be compared to those of the three selected participants to illustrate why they were chosen over the other students.

When responding to questions about the existence of a supernatural force or being, 100% of the participants expressed the belief that there is a God that is beyond nature. Although one would perhaps expect that one or two participants would not believe in God, the response was somewhat anticipated because of the demographics of the student body. Some of the general responses were:

- I believe in God.
- I believe God is beyond our world, and He is a supreme being. I don't believe there is anybody else but Him.
- I think God is completely sovereign, and is beyond all things.

Even with one unique response, which will be described later, all of the participants agreed that the supernatural force or being (i.e., God according to everyone's response) has some impact on our personal life and on natural process. Some of the general responses are:

- Yes, a huge impact, such as prayer. I think through prayer anything is possible. I know that from personal experience. Because I wasn't going to church as much, and I've been going a lot more lately. It makes a big difference in how you feel about yourself and the decisions you make
- I think He has every impact on our life. I think the stuff that we go through is for a reason, and He puts us through that for a reason. [God also has impact on nature with things like] storms.

- I believe that God has something to do with our personal lives. I don't think He necessarily knows exactly what we are going to do, but He knows that we will have to make a choice. He has an influence on the choices that we make. I also think He impacts nature. For example, that a child will be born on a certain date with a disease, so the child or his parents can get something out of the child having the disease. Or the child may help find a cure for that disease, so he can help other people. So I think there is a purpose for why they have the disease. I think there is a purpose for everything.
- Of course, because He created it. I think He controls what goes on with nature. Such as, He made the Earth orbit in the way it does so we have seasons and night and day. The fact that if we were just a little bit closer to the sun, we would probably burn up. And if we were just a little bit farther away we would freeze to death. I just don't think all of that could happen out of coincidence.
- He has an impact on our life because He created us, and He gave us what we have, like our feelings and emotions. [Also] nature is His, so He does what He wants with it. He creates tornadoes, if He chooses to.
- If you put Him first in your life, then He can pretty much do anything in your life. For example, a friend of mine drank before she accepted Christ, and now she fully changed her life around. Her grades improved, and she's not in trouble with her mom anymore. Her whole live has done a 180. He decides what goes on in the world, since He controls it. Such as,

the other day, if it rained, we would have had to take our math test. And I hadn't studied the night before, because I didn't think we would have the test. So I prayed that it would not rain, and the sun came out, after being cloudy the entire morning and looking like rain.

Although there were various degrees of involvement, when asked, "According to what you believe is true, how did the universe, earth and living things come about?" there was again 100% agreement that God had something to do with this. Some of the general responses were:

- I believe the universe was created by God. Well, I believe certain things have evolved, but not from what He has made. I think things evolve to adapt to the changes in the universe, but I think everything that was first created was created by Him. Things that have changed since then have only changed to adapt or become part of the environment.
- I personally believe that God created the earth in six days and rested on the seventh.
- I think that God created the earth. He just created Adam and Eve, and it just went from there. They kept producing. I don't believe the whole monkey theory. I can see where people would think that, but that's not my belief.
- I don't have any doubts that God created the universe, but by the same token, I think we progress, not necessarily from monkeys, but in technology, appearance, and size to better adapt to our environment.

- God created everything. He made the animals and the universe. He created it all out of what He imagined or thought it to be, for a place for us to live.
- God created the earth. I think things have adapted over time, for example maybe a polar bear used to be black and now it's white because of the conditions it lives in now is better. I don't think anything ever evolved. I think things adapted a little bit.

Yet again 100% of the participants felt that science and religion had contradictions or conflicts between them, and they all thought that the only conflict or contradiction revolved around the concepts of evolution. Some of the general responses about whether or not science and religion ever contradicted or had conflict are as follows:

- [They contradict] in evolution because people are so set in their views as far as people thinking they came from monkeys. It has a lot to do with science, and it has a lot to do with religion, because it deals with God, monkeys, and change. So, they probably do contradict because you will avoid different things. Sometimes you can't change some people. They won't budge at all.
- I think it does, because very religions people say God created us, and die-hard evolutionist say, "Look at the facts."
- In evolution, scientists believe that maybe humans evolved from apes. My favorite one is fish. The fish jumped out of the water, and their fins got stuck in the tree, and they got stretched out. That is the weirdest one I've

ever heard in my life. God created the animals and humans, and the animals adapt to different surroundings. But I don't believe that we evolved from apes or different animals.

- A lot of scientific people believe in evolution rather than God creating the earth. Most people who believe in evolution don't believe in anything the Bible teaches. They don't believe in some of the miracles that God did that are recorded, like parting the Red Sea. They don't believe anything supernatural happens.

One of the most interesting findings from the preliminary interview questions came from the responses regarding whether or not the participant ever disagreed or had a problem with what was taught in a science class. Now, keep in mind that all but one participant expressed a belief in God, which had impact in his or her personal life and natural process, and that science and religion contradicted or conflicted with each other in the area of evolution. Only 40% of the participants had a problem with the teaching of evolution theory. A few general responses are:

- I disagree with evolution. That's about the only thing. But evolution also ties into a lot of other things that you study. Like when you study the different kingdoms, some of the things could have evolved from different things, or it could have just been there the entire time. But we don't exactly know. I think they classify that they have proof that it did, but they don't necessarily know if it actually did.

- Evolution. But how they say the world was created over billions of years ago, and how they say we came from evolution. Not really any other disagreements.

The other 60% of the participants had no problem with what is taught by science. A few of those general responses are:

- I don't really ever tend to disagree. I just learn it and take it in, and go with it. I don't really think too far into things. I just learn the basics and if something isn't taught to me, I don't really learn it on my own. I kind of believe everything I hear. I'm kind of gullible.
- I'm one of those people that if you can tell me why something happened, I'd be a believer. But if you can't explain it, there are no facts based on it, so I can't believe it.
- Not really, because I'm just the student. I don't feel I can disagree with something I don't really know about, if I'm just learning it for the first time.

Selection for the Final Phase

Now that the overall ideas of the preliminary interview questions are known, I would like to compare them to the three participants who were selected for the final phase of the study. The goal was to select one student from each of the three ontological positions, but since everyone accepted the idea that there is a supernatural force or being, it was not possible to have a participant in the No Supernatural category. So it became

necessary to choose a participant from the other two categories (i.e., Supernatural Without Impact and Supernatural Impact). When investigating the responses, there was only one participant, referred to as Edward, who could be placed into the category of Supernatural Without Impact. I will later explain why Edward was so labeled. Because of the dualistic nature of the responses to the question of whether or not students disagreed with something that was taught in science, I decided to choose two participants from the Supernatural Impact category who represented each perspective. Rueben, a pseudo-name, is holds a Supernatural Impact position, but does not have any disagreements or problems with what is taught in science, but Suzanne, a pseudo-name, holds a Supernatural Impact position and does have disagreements with what is taught in science.

Edward

Why did I choose these three participants? What set them apart from the rest? The easiest choice was Edward, because he was the only participant who could be classified as a Supernatural Without Impact. Edward's response to whether or not there is a supernatural force or being was, "The one word answer is yes, but it's more complex than that. I consider it to be as viable a theory as any other." As the interview process continued, he had no problem accepting the idea of a supernatural force or being. When asked if he could be sure if there was a supernatural force or being, he responded with, "There is no proof that such a being exists; there is really no proof that such a being doesn't or couldn't exist. There is no reason not to believe in it." Also, when he was asked about what impact the supernatural force or being has or could have if it is a plausible theory, he responded, "I think that makes about as much as anything. For

instance, you could accept that the universe began with a big bang, but you could also accept that maybe the big bang was a product of that supernatural force."

Rueben

The choice of the next two participants was a little more difficult, because all other students were classified as holding a Supernatural Impact position. As already mentioned, the Supernatural Impact group was dualistic in its disagreement of something that was taught in a science class. Rueben came from the group that had no disagreements with anything. His response to this question was, "I'm a person that kind of takes everything I learn. I don't really disagree with anything. I just sort of take everything in and agree with all of it." This was a typical response for the majority of the participants, so what set him apart from this subgroup? During the very first interview, which actually was with Edward, I asked a question that was not on the set of the preliminary interview questions due to Edward's responses. In doing so, I incorporated this question into the set of questions for all of the preliminary interviews. This question is similar to the contrived situation question that was presented earlier regarding the Grand Canyon. The reason for asking this question of Edward was that he seemed to be willing to accept any idea or theory, and I wanted to know when push came to shove, which explanation he would hold to. I asked, "If you were confronted with two explanations of how the Grand Canyon was formed, one saying that it occurred by natural processes of erosion by the Colorado River over a million years or so, or the other, which is based on the belief that God had an impact on its formation due to that area being a major drainage zone from the universal flood in which eroded it away in a

few hundred or thousand years, which of these two explanations would you tend to believe in?"

Rueben was one of two participants who did not respond to believing in the universal flood perspective. The reason I chose participants that accepted the natural process perspective was because that view demonstrated, even though on a small scale, their ability to use the concepts of the theory of evolution to answer a problem, which is a component of the conceptual change model (Cobern, 1996; Demastes & Others, 1996).

Now that I have narrowed the selection to two individuals, I then used responses to the biographical form that was filled out prior to the preliminary interviews to make the final selection. Keep in mind that the cooperating teacher checked the biographical form for accuracy, and Rueben's self-declared responses to his overall GPA, typical grade in science, and anticipated grade for the AP biology class were all-A's, but the other participant had all-B's. So Reuben was selected over the other participant due to his grades, which also compared favorably to Edward's all-A's responses. All three participants had all-A's for their responses.

Suzanne

Suzanne held a Supernatural Impact position representative of the subgroup that did disagree with some of the concepts that were taught in her science class. Her response to this question was a typical response for this subgroup:

> Yes, [I have disagreements.] When we have discussion time, and if your teacher doesn't believe the same thing you do, it's really hard. They think people just make [human evolution] up. Nobody really knows. Nobody really knows what went on. We get into a lot of heated

> arguments about who is right and wrong. You can't blame them for thinking they way they do, because people have studied this for 30 years, and that's all they know. Or they were never introduced to something that other people believe in. Their whole life is just what they studied.

In all questions of the preliminary interview, all of the participants in this subgroup had similar responses, but when I examined the biographical form, only Suzanne had responded with all A's to the questions of overall GPA, typical grade in science, and anticipated grade for the AP biology class, which was identical to Edward's and Reuben's responses. An overall comparison of the three selected participants to the general of the responses to the preliminary interview questions may be found in Table 4.1.

	Existence of Supernatural	Impact of Supernatural	Origins
General	I believe God is beyond our world, and He is a supreme being. I don't believe there is anybody else but Him.	He [God] has an impact on our life because He created us, and He gave us what we have, like our feelings and emotions. [Also] nature is His, so He does what He wants with it. He creates tornadoes, if He chooses to.	I think that God created the earth. He just created Adam and Eve, and it just went from there. They kept producing. I don't believe the whole monkey theory. I can see where people would think that, but that's not my belief.
Edward	The one word answer is yes, but it's more complex than that. I consider it to be as viable a theory as any other.	I think that makes about as much sense as anything. For instance, you could accept that the universe began with a big bang, but you could also accept that maybe the big bang was a product of that supernatural force.	I'm sort of shooting for a compromise, because I am religious and have been all my life, but I also think that the theory of evolution, if not a fact, at least is plausible and possible that it could have taken place that way, so I just try to keep an open mind about it.
Rueben	I believe that there is a God.	I think He does things for reasons. Everything is done for a reason. Say I would go out today and get in a car wreck and die. That's Him telling me that it is my time to go. I would accept that. I think He has a plan for everyone, and we all have to accept that. Also, the bad storm in '78. A truck was by the airport and covered with snow. It was left there for 2 weeks, and the guy inside lived. God had a reason for the blizzard, but He also had a reason for that guy living. He pretty much oversees everything that goes on.	I don't believe in [evolution]. I mean I understand where they're coming from, but I also believe in Christ and those beliefs also, like how the Bible describes creation.
Suzanne	I believe in God.	Yes, prayer changes a lot of stuff. My family has gone through some rough times, and we've really prayed, there are a lot of testimonies. Too many things happen that can be called coincidence, so there is another influence on life. He created everything. He knows how everything works, and how it wants to go. He has a plan. He knows what's going on, and it happens for a reason.	I go to church every week, and they always taught us that God created everything, so that's what I always grew up with. The preexisting cells make sense, because Adam and Eve had cells. So that's where I get everything.

Continued

Table 4.1: Comparison of Participants

Table 4.1 (Continued): Comparison of Participants

	Science vs. Religion	Disagree with Science Concepts	Agree with Science Concepts
General	[They contradict] in evolution because people are so set in their views as far as people thinking they came from monkeys. It has a lot to do with science, and it has a lot to do with religion, because it deals with God, monkeys, and change. So, they probably do contradict because you will avoid different things. Sometimes you can't change some people. They won't budge at all.	I disagree with evolution. That's about the only thing. But evolution also ties into a lot of other things that you study. Like when you study the different kingdoms, some of the things could have evolved from different things, or it could have just been there the entire time. But we don't exactly know. I think they classify that they have proof that it did, but they don't necessarily know if it actually did.	I don't really ever tend to disagree. I just learn it and take it in, and go with it. I don't really think too far into things. I just learn the basics and if something isn't taught to me, I don't really learn it on my own. I kind of believe everything I hear. I'm kind of gullible.
Edward	They do, but often it is a matter of interpretation. Science tends to work on theories, which are generally accepted but not proven. Religion can often be mistranslated or taken out of context. So there are lots of contradictions, but some of them are to varying degrees.	Yes and no. There are times when I like to prefer an alternative theory. It's not really an attempt to disagree. I just like to remain open minded. Like when we learned about gravity. I once heard what was meant to be a joke, but it was really an alternative theory of gravity. It is called the expanding matter theory. It was meant to be humorous, but at the same time, it explained gravity and everything it does. So I like to remain open minded about things like that.	
Rueben	[They contradict with the] evolution theory. The Bible doesn't say a blob produced everything that has risen through the years. I do understand the thing they're talking about with cells evolving into humans, but we have to start out somewhere, like with Adam and Eve.		I'm a person that kind of takes everything I learn. I don't really disagree with anything. I just sort of take everything in and agree with all of it.
Suzanne	In one of my classes we had a discussion about religion and how it ties into science. It depends on how you were taught. One of my teachers said whoever believes in God is wrong. It depends, because if one person is biased to anything open, like the teacher, they only teach you the scientific part. No one really knows, and that's what science is all about, finding out. I think it conflicts, because you already have one belief, like I grew up thinking there is a God and there could be some big miracle that there isn't. Which won't happen, but it conflicts with everything you ever thought. Nobody wants to think that what he or she really believe isn't true.	Yes, [I have disagreements.] When we have discussion time, and if your teacher doesn't believe the same thing you do, it's really hard. They think people just make it [human evolution] up. Nobody really knows. Nobody really knows what went on. We get into a lot of heated arguments about who is right and wrong. You can't blame them for thinking they way they do, because people have studied this for 30 years, and that's all they know. Or they were never introduced to something that other people believe in. Their whole life is just what they studied.	

CHAPTER 5

FINDINGS AND CONCLUSIONS

During the final phase of the study, information about the three participants began to emerge during the first of several meetings with them. I anticipated that the initial meeting with each of the students would last about 15 to 20 minutes, but during the first session we were so involved in a captivating discussion, the bell rang signifying the end of the period. How was that possible that we spent 55 minutes talking about education and worldview? We did not even finish with all of the inquiries by the end of the period. Luckily, none of the three had the same study hall period available to meet with me, so there wasn't a problem of rescheduling. I would have never guessed that 18-year-olds would be so interested in talking about their opinions and thought processes. Large public schools seem to have a reputation of hard-nosed kids that won't let you get to know them personally. So it was very refreshing to engage with students who had the amount of openness that was exhibited by all of the participants.

This chapter will discuss the hermeneutical dialectic cycle as it pertains to this study, a brief overview of the three selected participants, and an integration of the data and interpretation of the narratives. This integration of results and interpretations is necessary because the data and their interpretation are so closely related with each other; I will explain the deeper interpretation of the data after the tables that summarize the naïve interpretations of each participant. The concluding section will provide the

findings of the three major research questions, the implications of the findings, and other research questions that have arisen due to this research.

Hermeneutical Dialectic Cycle

The hermeneutical dialectic cycle has been described in Chapter 3. Hence, here I will describe the hermeneutical dialectic cycle as it pertains to this particular study. This hermeneutical dialectic cycle was a process in which individual participants and the researcher were involved in a series of audio taped, in-depth conversations, which then were transformed by the researcher into a narrative. Once a narrative was created, the editing process began solely by the participant until the resulting narrative accurately reflected what he or she thinks best represents his or her views. The initial discussion with each participant required two separate meetings, and the modification and editing cycle varied among the three, with Edward needing two more meetings and Rueben and Suzanne needing three more meetings.

Getting to Know the Participants

The general descriptions that follow will provide a foundation for the interpretation of each narrative. Reading the selection process of the participants provides some insight about them, but I will add some additional insight along with a review of what has already been mentioned. Some of the similarities include their age, 18, their all-*A* grades in science classes and overall grade point average (GPA), placement in AP biology class, and belief in a supernatural force or being that has impact on personal lives and natural processes.

Edward enjoys reading science fiction books and watching science fiction movies. He loves science, and took as many science classes that he could during his high school career. Because of his openness to alternative scientific theories or explanations for phenomena, he never got upset about learning any scientific concepts.

Rueben was the school's valedictorian, the starting varsity football quarterback, and a member of the varsity baseball team. He plans to attend Johns Hopkins University to earn a pre-med degree with anticipation of becoming a medical doctor. Even though he did not necessarily agree with all of the aspects of the theory of evolution, he never had any problems or issues learning about it.

Suzanne favorite class in school was science. She was a starting varsity volleyball player, and an outstanding track athlete, attending the state invitational meet in two events. Her future plans are to attend college to study in some area of science, which she will decide on after taking a few different science classes. She was very much opposed to any aspect of the theory of evolution, and had issues with learning about it.

All quotes are used to support my interpretation of the participants and come directly from the narratives that were produced through the final phase of this study.

Edward's Narrative

Naïve Interpretation/Understanding

Edward's narrative (Appendix E) expresses his ontological position as being Supernatural Without Impact because of his belief in a supernatural being, which he calls God, by stating, "I am a religious person, so I believe in God. There is probably at least something in the world that transcends science, which can't be described in purely

physical means." His belief in God is not sufficient in categorizing him as Supernatural Without Impact, but rather his inability to know for sure if this God has any impact on his life or on nature: "It is difficult to determine if God has any impact on our life or nature, because if you can't prove the fact that He exists, then you can't really measure His impact. Even though I think this intervention is possible, it does depend on how you interpret the situation, which may be explained by supernatural or by some other occurrence. It all depends on however you want to look at it."

Edward does not think that his acceptance of a supernatural being or his religion has any conflict with science, because "Science is a way of explaining how something works, and religion is a way of explaining why it works." Also he says, "Even if you go back to the beginning of time when the universe was created, science suggests that it may have begun with the Big Bang. Science has no idea as to why such an explosion would take place, so maybe God created the Big Bang, in which the Big Bang created the universe. Certainly God could use the theory of evolution as a means of human origins. Even the official churches have agreed that the Bible could be subject to interpretation." He further explains his trust in science and its theories by stating, "Belief in God does not necessitate that if you drop something that it won't fall to the ground." He accepts the ideas of science to be used for prediction and application, but also accepts that other ideas are also valid:

> All science is valid and so are all religious beliefs because even things as obvious as the theory of gravity are still just considered theory. They're just what people think are going on and as long as they work in a practical way such as the ability to use the theory of gravity to calculate the rate at

> which something will fall, then it's a useful skill and it works. Now I consider the theory of gravity in some ways to be more valid than the theory of evolution because you can observe the theory of gravity in action, when you drop something, it will fall. There is sufficient evidence for the theory of gravity, so I believe in it. I consider it perfectly valid as good of an explanation as any. I see no evidence that suggests that it is not true, so I might as well believe that it is true. I still consider the theory to be valid because it works under what we consider to be normal circumstances on this planet, even though in outer space such theories sometimes don't have the effect they do on earth. Perhaps our kind of theory is wrong or we just have the basic idea right and there are some variables we aren't considering. Perhaps there's just some completely other theory in which we haven't yet considered.

Edward thinks that the Bible does not need to be interpreted literally because it could have errors in it due to the many translations it has had. He says, "Especially when considering the Bible has been translated and changed many times. When the Bible says that He created everything in 7 days, maybe that's a metaphor or a mistranslation that means He created everything in 7 stages. It also might be just a prophet taking some poetic license."

Edward's above statement expresses his opinion of possible interpretation problems within the Bible. But he also thinks that there could be issues with a person's interpretation of the Bible, which is explained by this statement:

> I think for the most part anything in there [the Bible] can be true, but sometimes you have to either interpret it more or not interpret it at all. People like the Klu Klux Klan, and other stupid hatred groups, basically ignore the entire message of love and tolerance in the Bible by taking one quote a mile out of context to support their views, and then accept that as the law. The problem with interpretation is that anything can be interpreted anyway you want. Some read *Winnie the Pooh* stories, and interpret them as a metaphor for communism. Some say that the movie *The Matrix* contains Christian messages, which to a point that could be true, but really it's just the way you interpret it.

Edward's opinion that interpretation of the Bible or other forms of media is the key to understanding the media is also tied into how he thinks scientists interpret their observations during their investigations. He believes that some scientists "bend" the truth in order to make the data say what they want it to say. He says:

> When one considers the interpretation of scientific experiments, there is a limit that one can stretch before it breaks under the pressure of data. But still you see it all the time. For example, scientific studies by the medical community has thousands of examples of absolute proof that cigarettes cause cancer, but the cigarette companies have managed to skew the data to some point where it casts some reasonable doubt on the matter just to cover their rear-ends to keep selling their products. Their facts are valid

> for a certain definition of the word because, in the very direct sense, they're true, but it is really only a small picture of the whole truth.

Although he thinks that some scientists do have biases when doing their investigation, he does not believe this is the norm in the scientific community. This is evident in his statement, "For the most part, I think that the scientific community is filled with mostly objective people who like to form their theories after the evidence, rather than before. They have the proper training to make such observations, so I accept them as truth, but I always try to keep an open mind to alternatives and possible biases that influence their findings."

Even though Edward is very open to theories that are different from the accepted theory, he still insists that he be taught what is considered the leading theory because the only way to know what one truly believes is by seeing as many perspectives as possible. He states,

> If I am being taught information that there is an opposite view to, let's say the gravitational theory, then I should be taught the most prevailing view, but also keep an open mind to the alternative. The best way to keep an open mind is to learn everything you can about basically everything so that you can compare. Simply saying I don't want to learn about that because I would rather believe this, is pretty ignorant because you will really never know what it is you are believing and how it conflicts with what you don't want to believe. I liked to look at one idea and the other idea to find some way in which both could be true. I am open to learning

about anything because I always think you should be open about learning new things.

His beliefs come from "a combination of faith, common sense, observational evidence and open-mindedness."

Edward has no problems with the theory of evolution, his beliefs, or being taught about the theory of evolution: "So, when I am being taught the theory of evolution in a classroom, I have no qualms about being taught it, because the best thing I could do is to learning as much as I can about other ideas. I by no means think that my religious belief and the theory of evolution are mutually exclusive." And, "Throughout my education I have never had any conflict with what I was being taught, even with the theory of evolution." He thinks that religious people have problems with evolution and their religion because of their fear of finding some inaccuracies in their religion: "Sometimes people are too afraid to look closely at their religion because they're afraid that they'll discover a scientific explanation." On the other hand, he sees some non-religious people in fear of finding something that cannot be explained by science: "Then other people are too afraid to look at the universe scientifically because they're afraid they'll find something that can't be explained by science, which might only be explained by religion."

Science could have some impact on Edward's beliefs, but he doesn't think that his overall belief in God would be proven wrong because science and religion are two separate ways of knowing and cannot "prove" each other wrong:

Scientific evidence could cause me to redefine my beliefs, to reconsider them, to interpret them in a slightly different way, but I really don't think

> that there could be enough data to prove that the whole thing is false, and that there isn't anything out there. The entire point of faith is that you believe in something that you have no evidence of. For instance, I believe a table exists, because I can see it and feel it. I believe in God simply out of faith. I think He's out there but I have no way of observing or experimenting to determine if this is true. To suggest that anything that appeals to the five senses could question anything that doesn't, really doesn't make that much sense.

When Edward considers a concept that both his belief and science have an explanation (e.g. theory of evolution), he would like to find some type of compromise between them if at all possible:

> For instance, when you look at the skeleton of a dinosaur and the skeleton of a bird, one notices similarities in bone structure between them. There certainly is some evidence that the one may have evolved from the other, or at least had a common ancestor, but evidence that supports that view is not proof. Maybe some animals did come from other ones. Maybe other ones came spontaneously. Maybe God did create bacteria and let them evolve. Or maybe He did just create the Garden of Eden in 7 days like it says in the Bible. Anything is valid. For example, an interesting article suggests that the Bible might have been on to something when it discussed the way God created the earth in the book of Genesis. It says that He started out basically with the simplest things like creating the planet and then creating very tiny creatures and then creating plants and animals, and

them more complex animals, then finally humans. The Bible's idea syncs up almost perfectly with the theory of evolution, but the Bible was written thousands of years before that theory existed. Maybe the author had a lucky guess, or maybe he had his own theory of evolution that he chose to express in the creation of Eden, or maybe the Bible is true and he really was a prophet who received some kind of a message from a higher being. Whatever the case may be I do not see any reason why science and my beliefs have any conflicts with each other, because all ideas are possible and open for interpretation.

And if a complete explanation that could incorporate a compromise is not apparent to him, as in the case of human origins, then he will ultimately hold closer to his beliefs than to science. This is evident by him saying:

So when it comes to ideas that both my faith and science have an explanation about, like the question of human origins, I would like to think that there is some compromise, but in this case the two are particularly stringent. The Bible basically says that God put two humans on earth. While evolution says that there was something that happened over thousands of years, from rodents to monkeys to creatures from *2001: A Space Odyssey* to us. Also, the two are mutually exclusive and it's really just a matter of personal choice what I believe. In general, I believe the Bible's explanation, that God created them, but I also have seen plenty of

> evidence to support the contrary. I like to keep an open mind and constantly search for a compromise.

Even though he wants to hold to his religious beliefs, he still wants to find some type of compromise to avoid conflict between his beliefs and science. This is evident by this statement:

> I would be willing to update and alter my beliefs based on more scientific data. For instance, in the Bible it says Adam and Eve were created. It doesn't describe them. Perhaps they were Neanderthals. Perhaps they were some sort of subhuman that hadn't quite achieved our level and would continue to change over time. It really doesn't give enough details to be sure of what happened. It's all a matter of interpretation. The facts are there and the stories are there. It's just a matter of finding a way to sync up the two. If both sides are willing to make some compromises and accept some things that they don't have ample evidence of—maybe if the scientific community would accept that maybe there are things that we can't see and can't touch but they are nonetheless real. Maybe if the religious community could say, all right, maybe Adam and Eve were quite fully humans yet, maybe there were some sort of species that changed a little bit more into us, then I think some kind of common ground could be found.

Data from Edward's Narrative	Interpretation of Data
I am a religious person, so I believe in God. There is probably at least something in the world that transcends science, which can't be described in purely physical means. It is difficult to determine if God has any impact on our life or nature, because if you can't prove the fact that He exists, then you can't really measure His impact. Even though I think this intervention is possible, it does depend on how you interpret the situation, which may be explained by supernatural or by some other occurrence. It all depends on however you want to look at it.	His ontological position is Supernatural Without Impact because of his belief in a supernatural being, in which he calls, God, and his inability to know for sure if this God has any impact on his life or on nature.
Science is a way of explaining how something works, and religion is a way of explaining why it works. Even if you go back to the beginning of time when the universe was created, science suggests that it may have begun with the Big Bang. Science has no idea as to why such an explosion would take place, so maybe God created the Big Bang, in which the Big Bang created the universe. Certainly God could use the theory of evolution as a means of human origins. Even the official churches have agreed that the Bible could be subject to interpretation.	He does not think his acceptance of a supernatural being or his religion has any conflict with science
Belief in God does not necessitate that if you drop something that it won't fall to the ground.	He has trust in science and its theories.
All science is valid and so are all religious beliefs because even things as obvious as the theory of gravity are still just considered theory. They're just what people think are going on and as long as they work in a practical way such as the ability to use the theory of gravity to calculate the rate at which something will fall, then it's a useful skill and it works. I still consider the theory to be valid because it works under what we consider to be normal circumstances on this planet, even though in outer space such theories sometimes don't have the effect they do on earth. Perhaps our kind of theory is wrong or we just have the basic idea right and there are some variables we aren't considering. Perhaps there's just some completely other theory in which we haven't yet considered.	He accepts the ideas of science to be used for prediction and application, but also accepts that other ideas are valid.
Especially when considering the Bible has been translated and changed many times. When the Bible says that He created everything in 7 days, maybe that's a metaphor or a mistranslation that means He created everything in 7 stages. It also might be just a prophet taking some poetic license.	He thinks that the Bible does not need to be interpreted literally because it could have errors in it due to the many translations it has had.
I think for the most part anything in there [the Bible] can be true, but sometimes you have to either interpret it more or not interpret it at all. People like the Klu Klux Klan, and other stupid hatred groups, basically ignore the entire message of love and tolerance in the Bible by taking one quote a mile out of context to support their views, and then accept that as the law. The problem with interpretation is that anything can be interpreted anyway you want.	He thinks that there could be issues with a person's interpretation of the Bible.

Continued

Table 5.1: Summary of Naïve Interpretation of Edward's Narrative

Table 5.1 (Continued): Summary of Naïve Interpretation of Edward's Narrative

Data from Edward's Narrative	Interpretation of Data
For example, scientific studies by the medical community has thousands of examples of absolute proof that cigarettes cause cancer, but the cigarette companies have managed to skew the data to some point where it casts some reasonable doubt on the matter just to cover their rear-ends to keep selling their products. Their facts are valid for a certain definition of the word because, in the very direct sense, they're true, but it is really only a small picture of the whole truth.	He believes that some scientists "bend" the truth in order to make the data say what they want it to say.
For the most part, I think that the scientific community is filled with mostly objective people who like to form their theories after the evidence, rather than before. They have the proper training to make such observations, so I accept them as truth, but I always try to keep an open mind to alternatives and possible biases that influence their findings.	He thinks that some scientists do have biases when doing their investigation, but he does not believe that this is the norm in the scientific community.
If I am being taught information that there is an opposite view to, let's say the gravitational theory, then I should be taught the most prevailing view, but also keep an open mind to the alternative. The best way to keep an open mind is to learn everything you can about basically everything so that you can compare. Simply saying I don't want to learn about that because I would rather believe this, is pretty ignorant because you will really never know what it is you are believing and how it conflicts with what you don't want to believe. I liked to look at one idea and the other idea to find some way in which both could be true. I am open to learning about anything because I always think you should be open about learning new things.	He is very open to theories that are different from the accepted theory, he still insists that he be taught what is considered the leading theory because the only way to know what one truly believes is by seeing as many perspectives as possible.
So, when I am being taught the theory of evolution in a classroom, I have no qualms about being taught it, because the best thing I could do is to learning as much as I can about other ideas. I by no means think that my religious belief and the theory of evolution are mutually exclusive. Throughout my education I have never had any conflict with what I was being taught, even with the theory of evolution.	He has no problems with the theory of evolution, his beliefs, or being taught about the theory of evolution.
Sometimes people are too afraid to look closely at their religion because they're afraid that they'll discover a scientific explanation.	He thinks that religious people have problems with evolution and their religion because of their fear of finding some inaccuracies in their religion.
Then other people are too afraid to look at the universe scientifically because they're afraid they'll find something that can't be explained by science, which might only be explained by religion.	He sees some non-religious people in fear of finding something that cannot be explained by science.

Continued

Table 5.1 (Continued): Summary of Naïve Interpretation of Edward's Narrative

Data from Edward's Narrative	Interpretation of Data
Scientific evidence could cause me to redefine my beliefs, to reconsider them, to interpret them in a slightly different way, but I really don't think that there could be enough data to prove that the whole thing is false, and that there isn't anything out there. The entire point of faith is that you believe in something that you have no evidence of. For instance, I believe a table exists, because I can see it and feel it. I believe in God simply out of faith. I think He's out there but I have no way of observing or experimenting to determine if this is true. To suggest that anything that appeals to the five senses could question anything that doesn't, really doesn't make that much sense.	Science could have some impact on Edward's beliefs, but he doesn't think that his overall belief in God would be proven wrong because science and religion are two separate ways of knowing and cannot "prove" each other wrong.
For instance, when you look at the skeleton of a dinosaur and the skeleton of a bird, one notices similarities in bone structure between them. There certainly is some evidence that the one may have evolved from the other, or at least had a common ancestor, but evidence that supports that view is not proof. Maybe some animals did come from other ones. Maybe other ones came spontaneously. Maybe God did create bacteria and let them evolve. Or maybe He did just create the Garden of Eden in 7 days like it says in the Bible. The Bible's idea syncs up almost perfectly with the theory of evolution, but the Bible was written thousands of years before that theory existed. Maybe the author had a lucky guess, or maybe he had his own theory of evolution that he chose to express in the creation of Eden, or maybe the Bible is true and he really was a prophet who received some kind of a message from a higher being.	When Edward considers a concept that both his belief and science has an explanation about (e.g. theory of evolution), he would like to find some type of compromise between them if at all possible.
So when it comes to ideas that both my faith and science have an explanation about, like the question of human origins, I would like to think that there is some compromise, but in this case the two are particularly stringent. The Bible basically says that God put two humans on earth. While evolution says that there was something that happened over thousands of years, from rodents to monkeys to creatures from *2001: A Space Odyssey* to us. Also, the two are mutually exclusive and it's really just a matter of personal choice what I believe. In general, I believe the Bible's explanation, that God created them, but I also have seen plenty of evidence to support the contrary. I like to keep an open mind and constantly search for a compromise.	If a complete explanation could incorporate a compromise that is not apparent to him, as in the case of human origins, then he will ultimately hold closer to his beliefs than to science.
I would be willing to update and alter my beliefs based on more scientific data. For instance, in the Bible it says Adam and Eve were created. It doesn't describe them. Perhaps they were Neanderthals. Perhaps they were some sort of subhuman that hadn't quite achieved our level and would continue to change over time. It really doesn't give enough details to be sure of what happened. It's all a matter of interpretation. The facts are there and the stories are there. It's just a matter of finding a way to sync up the two.	Even though he wants to hold to his religious beliefs, he still wants to find some type of compromise to avoid conflict between his beliefs and science.

Depth Interpretation/Understanding

On the outset of the interpretation of Edward's narrative, it seemed as if his ontological position is Supernatural Without Impact. When directly confronted with a natural phenomenon, he would seek to use natural processes to describe his observations, yet he would allow for other models for interpreting that phenomenon. He does not want to reject any alternative theories, but holds that only naturalistic process could be supported by empirical evidence, and any theories that required supernatural intervention could only be believed and not supported because there would be no data. He wants everything to be valid and therefore will try to assimilate all concepts with some type of compromising model. Even when he considers the origins of humans, he wants to configure a rationale model that will agree with his beliefs and scientific studies. However, at the beginning when he could not verbalize a suitable compromising model, he felt compelled to lean to his beliefs. His decision to lean towards a supernatural act of the creation of Adam and Eve instead of the natural process of evolution shows that he does not truly align to the Supernatural Without Impact position. He would much rather hold to a supernatural impact for the origin of humans than to the naturalistic process.

This apparent deviation from Edward's ontological position did not cause him ever disagree with the tenants of evolution, even when considering human origins. He holds that a supernatural intervention for human origins is just what he believes, but that the evolutionary process is also an equally valid option. Even though he sees these as two different explanations for the same event, he thinks that there probably is some compromising model that may best explain human origins. With more scientific data and possibly a different interpretation of the creation story, Edward would not see these two

views as being in conflict or disagreement. The apparent deviation from his ontological position of Supernatural Without Impact could only occur when trying to explain past events and not current phenomena, and even when considering past events it will not pose any potential problems with the learning of such explanations because of his view that all explanations are valid explanations.

Rueben's Narrative

Naïve Interpretation/Understanding

Rueben's narrative (Appendix F) expresses his ontological position of Supernatural Impact because of his belief in a supernatural being, in which he calls "God," and because he knows for sure that God has impact on his life:

> I believe in God. He does everything for a reason. He is in charge of everything that goes on on earth. If I get in a car wreck, that is His way of saying that it is my time. I pretty much accept it. Some things you are in charge of and other things you are not. For example, a person getting in a car accident could have made a decision to drive drunk and therefore had the wreck, but then again the accident could be God's doing. I guess you can say that there are things that you have in your control and there are things that are in His control.

Rueben also says that God has impact on nature by stating, "God not only has some influence on human life, but also in nature. I think He is above everything. There have been years when God has determined that this year is going to be a dry spell, which affects the natural processes."

He views science as a process to learn and discover new things; in which will change as new information becomes available to researchers. He states:

> As I learn how a flower goes through its life cycle, … I accept what is in the textbook as being an accurate description of what really does occur in nature, because the scientists that investigated it actually observed the plant's life cycle. Science is changing all the time. I think it's evolving. Everything is changing. New things are being discovered. For instance, in the rainforest, there are insects that we haven't discovered that are evolving.

He agrees with the overall idea of change over time that is contained in the theory of evolution. He states, "There are always things that are new. This is evident in the taxonomy. Everything probably started with one bio and then everything just branched out into several different species—it has just evolved." But when considering the origins of humans, he does not hold to the theory of evolution. Rueben holds to a supernatural intervention for human origin stating, "However the origin of humans is a little different. The evolutionary theory does not provide the adequate explanation. I don't believe in the blob and that everything evolved from a lot of cells. I think that God put Adam and Eve here for a reason, and that everything evolved from them." He presents a unique mixture of the Biblical creation story and a sort of reverse evolutionary process, which uses the mechanisms of evolution:

> I know all organisms are related in some way but I guess it makes more sense to me that Adam and Eve was the beginning point for humans,

who produced all the humans that are here and then also the primates that are similar to us. I mean they kind of evolved from us, but then there were things way before Adam and Eve such as insects. Since God placed Adam and Eve here and humans branched out from them by reproducing and their children reproducing, then there would be similar makeup of blood type, DNA, other things. Of course, you're going to have incest with children of incest, and as a result you're going to have messed up chromosomes and stuff like that. That's why I see other primates coming from that process of reproduction of Adam and Eve.

Even though Rueben sees a conflict between science and religion in the area of evolution, he is quick to separate himself from those students that have a problem with this conflict:

> There are definitely conflicts between science and religion, and I definitely would say the evolutionary thing would be the biggest one. When we have talks about evolution in our science class, students would go off on the teacher. Students would come out of class angry, and say that the teacher has no right to say things like that, and things like that should just be kept to oneself. People that think this is a bigger issue have a bigger conflict with it. They would be the ones that would definitely speak up against the teacher teaching it, but that wouldn't be me though. I don't get upset or anything. I don't mix my beliefs with what I am being

> taught in school. I don't really have a thing about that kind of thing. I just keep science and my beliefs separate.

Rueben's lack of concern about the conflict between his beliefs and science carries over into his learning of the theory of evolution. Numerous times he mentions that it does not bother him to learn things that do not reflect his beliefs. Here are a few of his statements:

- It doesn't bother me that I am required to learn things that I don't agree with.
- I don't necessarily have a problem with learning things that I disagree with because that's what I need to learn and so, therefore, I learn it.
- I just accept what I am taught, and apply it to everyday life. I don't get upset or anything.

The main reason that Rueben learns what he does not agree with is because his grades are so important to him. He says,

> All through high school I had to accept what is in the textbook. I might have had my own theories on things, but that isn't going to help you take the test. Success in high school has always been a major concern of mine, and now that I am the valedictorian of this year's graduating class, I have seen my goal achieved. When I come to school, I believe what the textbook says or I'm not going to get a good grade on a test.

Even when he says that he will learn it because of using it later in life, it is based on classes he will take in college, not applying to life or future research. His grades will be

important to him in college, and therefore he will learn whatever he needs to in order to achieve. He says:

> I just put the information that I do not agree with into my long-term memory, because I will need to recall it when I have the final or when it comes up later in life. For instance, I'm going to go study a biology/pre-med major at Johns Hopkins in Baltimore and half the stuff I'm going to learn there, I may not believe, but because the textbook or the professor says it, I will believe it, no matter what. Even though I have a problem with what is being taught, I consider my grades, which are so important, and then learn what they are trying to teach me. It really doesn't affect me that much. When I go to college, I probably will handle this issue the same way I handle it now. I'm going to accept what the professor is teaching.

While Reuben thinks that he should have problems with learning something that he doesn't agree with, he doesn't: "It sounds bad that I don't have any problems when I am learning about issues that conflict with what I believe, because I am not defending what I believe in. I think it should affect me more than it does." He provides several reasons why it does not bother him to learn something that he does not agree with. One reason is already obvious by his past statements, that his grades and success in school does not allow him to be bothered. Another reason is because he does not like conflict. He says, "I'm pretty much left-brained, so everything needs to be black and white. So if the book tells me something, that's what I learn." Although it might seem that he is not bothered because he does not think about his beliefs while he is in the classroom, this is not the

case. He states, “As I learn how a flower goes through its life cycle, I always think about the God aspect, and I accept what is in the textbook.”

When Rueben is assessed in school he does not use his beliefs, but rather what is the acceptable answer. He states, “In school, I was taught that humans evolved through a process of changes. Even though I do not agree with this concept, if I was to answer a question on a test, I would answer with the accepted idea that was found in our science textbook.” He learns both scientific concepts that he agrees with and disagrees with in exactly the same way. He states:

> I don’t necessarily have a problem with learning things that I disagree with because that’s what I need to learn and so, therefore, I learn it. There is no difference in how I learn things that I do not disagree with compared to the things I do agree with. For example, I learned the concepts of the theory of gravity the same way that I learned the concepts of the theory of evolution.

So why doesn’t Reuben believe in the evolutionary process of human origins? He simply believes what he has been taught by his parents since he was a child. He says, “The reason I don’t accept the theory of evolution as the means by which humans originated is because what I’ve grown up with and been taught since I was a child, which is from a religious aspect.” He also believes what the Bible says is true, so he believes in the Biblical account of creation. He says, “My view of the Bible is that everything in it is accurate. I accept everything that’s in it.”

Data from Rueben's Narrative	Interpretation of Data
I believe in God. He does everything for a reason. He is in charge of everything that goes on on earth. If I get in a car wreck, that is His way of saying that it is my time. Some things you are in charge of and other things you are not. For example, a person getting in a car accident could have made a decision to drive drunk and therefore had the wreck, but then again the accident could be God's doing. I guess you can say that there are things that you have in your control and there are things that are in His control.	Rueben expresses his ontological position of a theist because of his belief in a supernatural being, in which he calls "God," and because he knows for sure that God has impact on his life
God not only has some influence on human life, but also in nature. I think He is above everything. There have been years when God has determined that this year is going to be a dry spell, which affects the natural processes.	Rueben thinks that God has impact on nature.
As I learn how a flower goes through its life cycle, … I accept what is in the textbook as being an accurate description of what really does occur in nature, because the scientists that investigated it actually observed the plant's life cycle. Science is changing all the time. I think it's evolving. Everything is changing. New things are being discovered. For instance, in the rainforest, there are insects that we haven't discovered that are evolving.	He views science as a process to learn and discover new things, which will change as new information becomes available to researchers.
There are always things that are new. This is evident in the taxonomy. Everything probably started with one bio and then everything just branched out into several different species—it has just evolved.	He agrees with the overall idea of change over time that is contained in the theory of evolution.
However the origin of humans is a little different. The evolutionary theory does not provide the adequate explanation. I don't believe in the blob and that everything evolved from a lot of cells. I think that God put Adam and Eve here for a reason, and that everything evolved from them.	But when considering the origins of humans, he does not hold to the theory of evolution. Rueben holds to a supernatural intervention for human origin.
I know all organisms are related in some way but I guess it makes more sense to me that Adam and Eve was the beginning point for humans, who produced all the humans that are here and then also the primates that are similar to us. I mean they kind of evolved from us, but then there were things way before Adam and Eve such as insects. Since God placed Adam and Eve here and humans branched out from them by reproducing and their children reproducing, then there would be similar makeup of blood type, DNA, other things. As a result of incest, you're going to have messed up chromosomes and stuff like that. That's why I see other primates coming from that process of reproduction of Adam and Eve.	He presents a unique mixture of the Biblical creation story and a sort of reverse evolutionary process, which uses the mechanisms of evolution.

Continued

Table 5.2: Summary of Naïve Interpretation of Rueben's Narrative

Table 5.2 (Continued): Summary of Naïve Interpretation of Rueben's Narrative

Data from Rueben's Narrative	Interpretation of Data
There are definitely conflicts between science and religion, and I definitely would say the evolutionary thing would be the biggest one. When we have talks about evolution in our science class, students would go off on the teacher. Students would come out of class angry, and say that the teacher has no right to say things like that, and things like that should just be kept to oneself. People that think this is a bigger issue have a bigger conflict with it. They would be the ones that would definitely speak up against the teacher teaching it, but that wouldn't be me though. I don't get upset or anything. I don't mix my beliefs with what I am being taught in school. I don't really have a thing about that kind of thing. I just keep science and my beliefs separate.	Even though Rueben sees a conflict between science and religion in the area of evolution, he is quick to separate himself from those students that have a problem with this conflict, in which he does not have.
It doesn't bother me that I am required to learn things that I don't agree with. I don't necessarily have a problem with learning things that I disagree with because that's what I need to learn and so, therefore, I learn it. I just accept what I am taught, and apply it to everyday life. I don't get upset or anything.	Rueben's lack of concern about the conflict between his beliefs and science carries over into his learning of the theory of evolution, because it does not bother him to learn things that do not reflect his beliefs.
All through high school I had to accept what is in the textbook. I might have had my own theories on things, but that isn't going to help you take the test. Success in high school has always been a major concern of mine, and now that I am the valedictorian of this year's graduating class, I have seen my goal achieved. When I come to school, I believe what the textbook says or I'm not going to get a good grade on a test.	The main reason that Rueben learns what he does not agree with is because his grades are so important to him.
I just put the information that I do not agree with into my long-term memory, because I will need to recall it when I have the final or when it comes up later in life. For instance, I'm going to go study a biology/pre-med major at Johns Hopkins in Baltimore and half the stuff I'm going to learn there, I may not believe, but because the textbook or the professor says it, I will believe it, no matter what. Even though I have a problem with what is being taught, I consider my grades, which are so important, and then learn what they are trying to teach me. It really doesn't affect me that much. When I go to college, I probably will handle this issue the same way I handle it now. I'm going to accept what the professor is teaching.	Even when he says that he will learn it because of using it later in life, it is based on classes he will take in college, not applying to life or future research. His grades will be important to him in college, and therefore he will learn whatever he needs to in order to achieve.

Continued

Table 5.2 (Continued): Summary of Naïve Interpretation of Rueben's Narrative

Data from Rueben's Narrative	Interpretation of Data
It sounds bad that I don't have any problems when I am learning about issues that conflict with what I believe, because I am not defending what I believe in. I think it should affect me more than it does.	While Reuben thinks that he should have problems with learning something that he doesn't agree with, he doesn't.
I'm pretty much left-brained, so everything needs to be black and white. So if the book tells me something, that's what I learn.	One reason why it does not bother him to learn something that he does not agree with is he does not like conflict.
As I learn how a flower goes through its life cycle, I always think about the God aspect, and I accept what is in the textbook.	He does consider his beliefs when he learns science.
In school, I was taught that humans evolved through a process of changes. Even though I do not agree with this concept, if I was to answer a question on a test, I would answer with the accepted idea that was found in our science textbook.	When Rueben is assessed in school he does not use his beliefs, but rather what is the acceptable answer.
In school, I was taught that humans evolved through a process of changes. Even though I do not agree with this concept, if I was to answer a question on a test, I would answer with the accepted idea that was found in our science textbook.	When Rueben is assessed in school he does not use his beliefs, but rather what is the acceptable answer.
I don't necessarily have a problem with learning things that I disagree with because that's what I need to learn and so, therefore, I learn it. There is no difference in how I learn things that I do not disagree with compared to the things I do agree with. For example, I learned the concepts of the theory of gravity the same way that I learned the concepts of the theory of evolution.	He learns both scientific concepts that he agrees with and disagrees with in exactly the same way.
The reason I don't accept the theory of evolution as the means by which humans originated is because what I've grown up with and been taught since I was a child, which is from a religious aspect.	He simply believes what he has been taught by his parents since he was a child.
My view of the Bible is that everything in it is accurate. I accept everything that's in it.	He also believes what the Bible says is true, so he believes in the Biblical account of creation.

Depth Interpretation/Understanding

Rueben's narrative describes a student that has a Supernatural Impact ontological position, but it would be very possible for a science teacher not to recognize this. He would never disagree with the teacher or the textbook. He never would comment that he does not believe in the evolutionary process of human origins. Any assessment would verify his knowledge and understanding of the theory of evolution. All of this, and Rueben does not agree with it at all. He demonstrates the ability of a student to have a dichotomy between his beliefs and his schooling. His religion is for home and church, not for school. What he accepts as truth at home or church is not what he accepts a truth in school. This dichotomy is why Rueben has a plagiaristic understanding of the evolutionary process of human origins. His grades exemplify his comprehension of the concept, but do not verify conceptual change. The only reason he would use this information again is for future tests or college classes.

The dichotomy between beliefs and science allows Rueben to have no problems with the learning of concepts with which he does not agree. Therefore, he does not have to assimilate or accommodate these scientific concepts with his beliefs because he simply accepts them into his construct. The potential conflict between his beliefs of the Biblical account of human origins and the evolutionary account of human origins never is questioned in his worldview because he keeps them separate. Therefore he has no problems with the potential conflict, because he doesn't try to justify his perspective, so he doesn't have to search for any compromising explanations. I am not suggesting that he does not have the ability to critically think, but that it appears that he quickly wants to elude any controversy or disagreements by accepting it and not investigating it any

further. Maybe if he investigated this potential conflict, he would find that his beliefs are not that much different from what the empirical evidence suggests.

Suzanne's Narrative

Naïve Interpretation/Understanding

Suzanne's narrative (Appendix G) expresses her ontological position of a theist because of her belief in a supernatural being, in which she calls "God," and because she knows for sure that God has impact on her life:

> God is everything to me. Things in life happen for a reason, and He is the reason for it happening. He's like the writer of the story and we are the characters in His book. We're God's masterpiece; the earth is also His masterpiece. That was what I was always taught; that's what I believe. See, it's my decision to follow Him. I could go down another path; that's when I decide to open my heart to Him and tell Him, "I will follow You." He loves us all, and I know He's going to be with me, and I am striving to be like Him. My goal is to be like Him. God's impact on us is evident by how He guides us. When I am faced with temptations, and if I choose to follow His path, He will lead me to something better.

Suzanne also says that God has an impact on nature:

> If I pray, He can have a direct impact on someone. It's not like I can call him from a phone to talk to Him, but He still does have direct impact, if He decides to answer my request. God can heal people, which is evident because the doctors have no idea how the person got better. For

example, when people get cancer. Some cases the doctors say that there isn't a way to get rid of the cancer. Then prayers might be offered for this person with cancer, and then completely recover. It is obvious to me that it was a miracle or a blessing from God because nobody else has an explanation for it. So God changed the natural course of what should have occurred and impacted that person.

Although God does have impact on nature, she does not necessarily think that He is continually changing or causing natural processes to occur, rather she thinks that God will only intervene in His creation when He wants people to know He exists. She states:

> Now, I don't want to give the impression that science cannot explain things; because there are some things that science can explain, like the cell and cell divisions. With cell division you have natural process that will occur. Although God could have impact on cell division if He wanted to, He typically does not interfere with natural forces. He doesn't one day just out of the blue say I'm going to change it, because it's His creation and His masterpiece. He only has a reason to change it when He wants people to see that He exists. He wants people to understand His creation, and so by changing the natural process would confuse people that are trying to know how it works.

She thinks science is useful for understanding things about nature because God wants humans to understand His creation. She says, "Science is a way of knowing, like studying how things work, and how everything connects. You can use the scientific

method to experiment and know certain facts about nature. Facts are something that you know because you tested them over and over again, and have proved that they are true."

Suzanne does hold to some of the mechanisms of the theory of evolution, like mutation, adaptation, and selection. She says:

> For instance, maybe a plant had a mutation when it produced one little seed. If that seed survived, it survived for a reason. Maybe it is adapting to something and it's also going to produce more of those mutants just like it. So maybe it's coming up with a new species to adapt to what is happening to that specific organism on earth. It's changing and adapting for a reason.

Although she knows science provides a way of knowing, she also thinks God provides another way of gaining truth and knowledge. She says, "Now my religion is similar to science in the way that it too is a way of knowing things, but it is based on faith not experimentation." She sees the Bible as a book without errors that can help her live her life. She states:

> I believe that the Bible is accurate and contains truth. The Bible is more or less like a Christian's textbook to life. If I have any questions about life, then I can read the Bible and find the answer, because the lessons in the Bible are going to reoccur, so I will be able to find guidance by the principles that are in it. The Bible has never been revised or corrected because it doesn't have any errors in it.

When she considers the area of human origins, the truth found by science and the truth stated in the Bible contradicts, and she cannot understand how the evolutionary process works. She states:

> Most of the time the truth that I find in the Bible agrees with the truth found by science, but there is one area that they do contradict, and that is in the areas of evolution. Let's take human origin as an example. In the Bible it says that Adam and Eve were the first humans. Science teaches the natural process of starting from a lower species, which had to go through changes to eventually have humans. This natural process doesn't make any sense to me. Why couldn't God just make Adam and Eve to begin with and let them produce what we have today? Science and my belief in human origin don't fit together at all because one says that humans were created and the other says that humans got here through many changes.

She does not agree with the evolutionary explanation of human origin, but she sees it as a possible process. She says, "I don't really believe it, but I guess it's a possibility. It's just another side to a story. You have this side of the story and you have my side of the story."

In some ways, Suzanne outwardly appears to learn concepts that she agrees with and something that she disagrees with in the same way. She says, "When I am taught about the theory of evolution, I just listen and take notes like I always do. When the test comes, I write it down whatever the teacher says in class." But inwardly, she does not learn the same way. For example, she is not an active participant in class, does not think

in-depth about concepts, will not apply them later in life, and reports that she will forget about them as soon as that section is finished. She states:

> If I agree with the concept being taught, then I think about it more in depth and I participate in classroom discussions about it. When I am studying something that I disagree with, I just flip the card over to see if I was right, but I don't think about it. On test, I just write it down and forget about it. When I read the question and I know the answer and I just write it down and I don't think about it. I don't think about it deep, because I just don't care, and I will just forget about it later.

Also her lack of motivation makes it more difficult to understand concepts with which she disagrees. She says, "It is more difficult to learn things that I don't believe in because I don't have the same kind of passion and motivation to learn it as I do everything else." Yet she is able to learn these concepts even though it is more difficult. She says, "Even though I disagree with the theory of evolution, I still understand the ideas behind it. I have always received an A in my science classes, no matter if I agreed with it or not."

Even though Suzanne does not agree with the evolutionary explanation of human origins, she wants to learn about the process, for the sake of knowledge and because it will provide insight for her own understanding and/or for helping someone else's understanding. She states:

> Knowing what other people think is actually really a good thing. Like, people always say listen to your enemies because they tell you your faults. That's kind of like the same thing. You may not always agree with

somebody, but listening to his or her side of the story isn't going to hurt you. It can help us understand where another person is coming from. Maybe it can help you explain something that you have trouble with or learn their little piece to help put your pieces together to come up with something new that you didn't know before. Knowledge is power.

She has no problems with learning about the concepts of evolution, as long as it is presented or taught in an appropriate way. She states:

> I really try to not let the teaching of evolution bother me because I know that they are teaching because they have to. So I just sit there and I don't really apply it to anything to my life. I'm kind of like a machine. I take it in. If teachers don't force it on you, and if they don't think that their way is the only way, then I don't get upset. I only remember one time ever really getting angry with a teacher, not just because of what they were teaching, but rather how they were teaching it.

When assessed over concepts that she disagrees with, she demonstrates or answers according to what has been taught and not what she believes. She says, "If I have to answer questions on any test, I just choose what is considered the most accepted theory—the Darwinian theory." Although when she is asked her opinion about a topic, she is willing to express her beliefs: "If I am asked my opinion, I tell them what I think is the truth."

Suzanne does not believe in anything that is contradictory to the Bible, because she believes in it more than anything else, and no amount of scientific evidence will be able to sway her opinions. She states:

> The main reason that I disagree with evolution is because ever since I was little I was taught about the Bible. Everything that I believe in now does not agree with the theory of evolution, so I don't believe it. My faith in God and the Bible is a lot stronger than some theory of evolution, and no amount of proof will ever get me to change my faith. No other topic, whether in science or in any other subject, do I have this strong of beliefs about.

She is willing to try to find some common ground, but "there comes a point that they don't fit together like people hope they would."

Data from Suzanne's Narrative	Interpretation of Data
God is everything to me. Things in life happen for a reason, and He is the reason for it happening. He's like the writer of the story and we are the characters in His book. We're God's masterpiece; the earth is also His masterpiece. That was what I was always taught; that's what I believe. See, it's my decision to follow Him. I could go down another path; that's when I decide to open my heart to Him and tell Him, "I will follow You." He loves us all, and I know He's going to be with me, and I am striving to be like Him. My goal is to be like Him. God's impact on us is evident by how He guides us. When I am faced with temptations, and if I choose to follow His path, He will lead me to something better.	Suzanne expresses her ontological position of a theist because of her belief in a supernatural being, in which she calls "God," and because she knows for sure that God has impact on her life.
If I pray, He can have a direct impact on someone. It's not like I can call him from a phone to talk to Him, but He still does have direct impact, if He decides to answer my request. God can heal people, which is evident because the doctors have no idea how the person got better. For example, when people get cancer. Some cases the doctors say that there isn't a way to get rid of the cancer. Then prayers might be offered for this person with cancer, and then completely recover. It is obvious to me that it was a miracle or a blessing from God because nobody else has an explanation for it. So God changed the natural course of what should have occurred and impacted that person.	Suzanne also says that God has an impact on nature
Now, I don't want to give the impression that science cannot explain things; because there are some things that science can explain, like the cell and cell divisions. With cell division you have natural process that will occur. Although God could have impact on cell division if He wanted to, He typically does not interfere with natural forces. He doesn't one day just out of the blue say I'm going to change it, because it's His creation and His masterpiece. He only has a reason to change it when He wants people to see that He exists. He wants people to understand His creation, and so by changing the natural process would confuse people that are trying to know how it works.	She does not necessarily think that He is continually changing or causing natural processes to occur. Rather she thinks that God will only intervene in His creation when He wants people to know He exists.
Science is a way of knowing, like studying how things work, and how everything connects. You can use the scientific method to experiment and know certain facts about nature. Facts are something that you know because you tested them over and over again, and have proved that they are true.	She thinks science is useful for understanding things about nature because God wants humans to understand His creation.
For instance, maybe a plant had a mutation when it produced one little seed. If that seed survived, it survived for a reason. Maybe it is adapting to something and it's also going to produce more of those mutants just like it. So maybe it's coming up with a new species to adapt to what is happening to that specific organism on earth. It's changing and adapting for a reason.	Suzanne does hold to some of the mechanisms of the theory of evolution, like mutation, adaptation, and selection.

Continued

Table 5.3: Summary of Naïve Interpretation of Suzanne's Narrative

Table 5.3 (Continued): Summary of Naïve Interpretation of Suzanne's Narrative

Data from Suzanne's Narrative	Interpretation of Data
Now my religion is similar to science in the way that it too is a way of knowing things, but it is based on faith not experimentation.	Although she knows science provides a way of knowing, she also thinks God provides another way of gaining truth and knowledge.
I believe that the Bible is accurate and contains truth. The Bible is more or less like a Christian's textbook to life. If I have any questions about life, then I can read the Bible and find the answer, because the lessons in the Bible are going to reoccur, so I will be able to find guidance by the principles that are in it. The Bible has never been revised or corrected because it doesn't have any errors in it.	She sees the Bible as a book without errors that can help her live her life.
Most of the time the truth that I find in the Bible agrees with the truth found by science, but there is one area that they do contradict, and that is in the areas of evolution. Let's take human origin as an example. In the Bible it says that Adam and Eve were the first humans. Science teaches the natural process of starting from a lower species, which had to go through changes to eventually have humans. This natural process doesn't make any sense to me. Why couldn't God just make Adam and Eve to begin with and let them produce what we have today? Science and my belief in human origin don't fit together at all because one says that humans were created and the other says that humans got here through many changes.	When she considers the area of human origins, the truth found by science and the truth stated in the Bible contradicts, and she cannot understand how the evolutionary process works.
I don't really believe it, but I guess it's a possibility. It's just another side to a story. You have this side of the story and you have my side of the story.	She does not agree with the evolutionary process of human origin, but she sees it as a possible explanation.
When I am taught about the theory of evolution, I just listen and take notes like I always do. When the test comes, I write it down whatever the teacher says in class.	In some ways, Suzanne outwardly appears to learn concepts that she agrees with and something that she disagrees with in the same way.
If I agree with the concept being taught, then I think about it more in depth and I participate in classroom discussions about it. When I am studying something that I disagree with, I just flip the card over to see if I was right, but I don't think about it. On test, I just write it down and forget about it. When I read the question and I know the answer and I just write it down and I don't think about it. I don't think about it deep, because I just don't care, and I will just forget about it later.	But other ways and inwardly, she does not learn the same way. For example, she is not as active of a participant in class, does not think in-depth about it, will not apply it later in life, and will forget about it as soon as that section is finished.

Continued

Table 5.3 (Continued): Summary of Naïve Interpretation of Suzanne's Narrative

Data from Suzanne's Narrative	Interpretation of Data
It is more difficult to learn things that I don't believe in because I don't have the same kind of passion and motivation to learn it as I do everything else.	Also, her lack of motivation makes it more difficult to understand concepts with which she disagrees.
Even though I disagree with the theory of evolution, I still understand the ideas behind it. I have always received an A in my science classes, no matter if I agreed with it or not.	Yet she is able to learn these concepts even though it is more difficult.
Knowing what other people think is actually really a good thing. Like, people always say listen to your enemies because they tell you your faults. That's kind of like the same thing. You may not always agree with somebody but listening to his or her side of the story isn't going to hurt you. It can help us understand where another person is coming from. Maybe it can help you explain something that you have trouble with or learn their little piece to help put your pieces together to come up with something new that you didn't know before. Knowledge is power.	Even though Suzanne does not agree with the evolutionary process of human origins, she wants to learn about it, for the sake of knowledge and because it will provide insight for her own understanding and/or for helping someone else's understanding.
I really try to not let the teaching of evolution bother me because I know that they are teaching because they have to. So I just sit there and I don't really apply it to anything to my life. I'm kind of like a machine. I take it in. If teachers don't force it on you, and if they don't think that their way is the only way, then I don't get upset. I only remember one time ever really getting angry with a teacher, not just because of what they were teaching, but rather how they were teaching it.	She has no problems with learning about the concepts of evolution, as long as it is presented or taught in an appropriate way.
If I have to answer questions on any test, I just choose what is considered the most accepted theory—the Darwinian theory.	When assessed over concepts that she disagrees with, she demonstrates or answers according to what has been taught and not what she believes.
If I am asked my opinion, I tell them what I think is the truth.	Although when she is asked her opinion about a topic, she is willing to express her beliefs.
The main reason that I disagree with evolution is because ever since I was little I was taught about the Bible. Everything that I believe in now does not agree with the theory of evolution, so I don't believe it. My faith in God and the Bible is a lot stronger than some theory of evolution, and no amount of proof will ever get me to change my faith. No other topic, whether in science or in any other subject, do I have this strong of beliefs about.	Suzanne does not believe in anything that is contradictory to the Bible, because she believes in it more than anything else, and no amount of scientific evidence will be able to sway her opinions.

Depth Interpretation/Understanding

Suzanne's Supernatural Impact ontological position provides her with beliefs that not only does she feel strongly about, but will also supercede any scientific evidence that is presented in contrast to her position. Presenting more data is unlikely to change her plagiaristic knowledge of the evolutionary process of human origins, but it could only be overcome by incorporating her ontological position into the teaching of this concept. Allowing her to critique her beliefs, or investigate how her beliefs and the scientific evidence might work together will provide an opportunity for her to change her plagiaristic knowledge into conceptual change.

She automatically turns off in-depth thinking (e.g. logic and analysis) when she is presented information that she disagrees with, and is not motivated to understand these concepts. Therefore, she has more difficulty comprehending concepts. However she is still able to demonstrate to the teacher her ability to do this by responding on tests the way she thinks the teacher wants. As long as the teacher presents the information in a Supernatural Impact friendly manner, she will not have problems with these concepts. In no way does she check her religion at the door when she enters the classroom, but rather she has become an inactive cognitive member of the classroom. The only way that she would come out of this cognitive coma is if the teacher threatened her ontological position in his or her manner of presentation or by incorporating some culturally relevant pedagogy.

Conclusions

Range of Ontological Positions

The preliminary interviews seemed to suggest that the range of ontological positions among students within this science class is not as wide as the three general positions of No Supernatural, Supernatural Without Impact, and Supernatural Impact. Even though no student was found to hold the No Supernatural viewpoint, and only one held the Supernatural Without Impact view, the AP biology class had a range of ontological positions in regard to their willingness to leave one ontological position and hold to another, depending on the situation. This was evident by Edward leaving his Supernatural Without Impact ontology to respond to questions of human origins. Also, both Rueben and Suzanne were willing to answer whatever the teacher wanted in order to get the grade. Therefore, if one were trying to determine his or her ontological position based solely on assessments performed by the teachers, it would appear that they held No Supernatural views.

This is possibly why the results of some previous studies of students with nonscientific beliefs appeared to show that the students that held such beliefs did not understand scientific concepts as well as their counterparts (Faiver & O'Brien, 1993; Lawson, 1990; Sinclair & Pendarvis, 1998). For example, Lawson (1990) asked the participants to respond with a Likert-type number to a series of questions, which would categorize them into certain worldviews. A few examples of the questions are as follows:

- Through the ages living things have changed and developed from simple to complex.
- Living things look essentially the same today as when life first appeared on Earth.

- Through the ages the kinds of living things on Earth have changed to "fit" their changing environment.
- Darwin's theory of evolution through natural selection is essentially correct.

If Rueben and Suzanne were presented these questions during their science class, both would likely respond according to how they were taught, how materials was presented in the textbook, or the most acceptable explanation, which is in accordance with evolutionary theory. Lawson would probably have categorized them in as not holding nonscientific beliefs, which would be incorrect. For this reason, the hermeneutical cycle has provided a more accurate description of the participant's beliefs.

Ontological Influence on Learning Human Origins

Considering the Supernatural Without Impact ontology, Edward had no problem whatsoever learning about scientific theory or explanation. He felt that all ideas were valid, and therefore had no issues with the learning of human origins according to the theory of evolution. However, with the same could be said regarding the Supernatural Impact position of Rueben. He did not have any problem either, but not for the same reason. He never considered whether or not his beliefs affected what he was learning in science because his religious beliefs were for home and church, not for school. His dichotomous worldview allows him to construct knowledge as a Supernatural Without Impact or as a No Supernatural learner. This is not the case when considering the Supernatural Impact position of Suzanne. She does not have a dichotomous worldview like Rueben. Because she considered her religious beliefs when she was in the classroom, it influenced her learning. As stated before, Suzanne found it more difficult to

learn concepts that she did not agree with than the ones that she did. She lacked motivation to learn, was not able to make connections to concepts that would be used for daily application (i.e., what she did agree with), and was unwilling or unable to use higher levels of thinking. The influence of her ontological position would only be enhanced by teacher practices that threatened her Supernatural Impact position. If such were the case, she might not be willing to entertain a lower level of thinking, and might reject all such notions that opposed her belief. Rueben and Suzanne have similar ontological positions, but apply it much differently. This further exposes the range that exists within a single ontological position.

Students that do not believe in the concepts to be learned are still able to develop cognitively a plagiaristic knowledge of the concepts based on their comprehension of the concepts. This plagiaristic knowledge does not necessitate an accommodation, assimilation or rejection of the concepts, but rather allows the student to remember the concepts for more or less trivial purposes and never conceptualize them into their overall framework. Rueben and Suzanne are examples of students that have mastered the game of school in order to jump through any hoop that is needed in order to "get the grade."

In the case of the students that have a Supernatural Without Impact position, they should not be influenced by their ontological position in order to accommodate, assimilate or reject the concepts of human origins. Even with Edward's willingness to believe that God created Adam and Eve, he continued to accommodate his worldview with that of scientific evidence. This was possible because he was willing to accept any explanation without reservations, which provided him with apprehension to produce conceptual change, rather than producing plagiaristic knowledge.

Implications

It is not necessary for teachers to label every student's ontological position in order to provide culturally relevant pedagogy. However, a general understanding of these three positions and an understanding of how a student may use his or her position may help teachers choose effective pedagogy when presenting concepts related to evolution. Without the use of alternative assessments, students like Rueben could appear to comprehend concepts, but never have conceptual change, which is debilitating because his scientific conceptualization of evolution would only be formed within his plagiaristic knowledge and not as a unifying concept throughout the sciences. The use of alternative assessments within the constructivism paradigm will allow students to individualize their construction of knowledge, so that they may consider their beliefs, opinions, or other explanations to the nature of science. If Suzanne is able seemingly to demonstrate comprehension of concepts she has never considered in depth, then teachers must be more proactive in providing students with the opportunity to think at higher levels. Isn't one of the goals of science education to motivate students to critically think and be problem solvers?

Science educators must also be cautious in how they teach any concepts of evolution, especially those relating to human origins. Comments in the preliminary interviews and the hermeneutical dialectic cycle overwhelmingly illustrated how students will react to the concepts of evolution. Also, the way the teacher presented these concepts influenced whether certain students would be hostile or not during the learning process. Just mentioning the word "evolution" brings certain students to a hostile and

defensive position. As is the case with Suzanne, no amount of scientific evidence seemed to encourage her to change her belief about God's intervention in human origins. I am certain that Suzanne's is not an isolated case in which this is true. This situation creates a certain dilemma for science educators.

Further Research Needed

If students will not accept scientific evidence as a reason for changing their beliefs, then what can science educators do to transform plagiaristic knowledge into conceptual change? Cobern (1996) suggests that students must engage in discussion about their worldviews, but what does that mean? How is it manifested inside of a classroom with 20 to 30 students? Even though there are many published suggestions regarding how evolution should be taught in schools, none of them considers students ontological positions. So, what is culturally relevant pedagogy with respect to students' ontological positions in science?

This study was based on an assumption of the student's ability to verbalize his or her beliefs in an interview and an in-depth conversation. Does a student's ability to communicate such ideas change as the maturity level changes? And if it does change, what is the nature of that change? Is there a certain Piagetian level below which students are unable to verbalize their worldviews?

The overwhelming percentage of students in this study had Supernatural Impact ontology. What caused this? Is the major influence on students ontological positions their parents, their teachers, their peers, or the culture? What is the role of the teacher in the construction process of a worldview of a student? What is an effective way to teach evolution to students like Suzanne?

Research-based answers to these and related questions should provide a stronger foundation for science educators to stand on when challenging future scientists and others among whom we hope to nurture scientific literacy.

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APPENDIX A

PARENTAL CONSENT FORM

(Printed on OSU letterhead)

Protocol # _____

Consent for Participation in Research

I consent to my child's participating in research entitled: Effects of a Student Worldview on the Cognition of Human Origins.

David Haury, Principal Investigator, or his authorized representative, Jeremy Ervin has explained the purpose of the study, the procedures to be followed, and the expected duration of my child's participation. Possible benefits of the study have been described, as have alternative procedures, if such procedures are applicable and available.

I acknowledge that I have had the opportunity to obtain additional information regarding the study and that any questions I have raised have been answered to my full satisfaction. Furthermore, I understand that My child is free to withdraw consent at any time and to discontinue participation in the study without prejudice to my child.

Finally, I acknowledge that I have read and fully understand the consent form. I sign it freely and voluntarily. A copy has been given to me.

Date: _____ Signed: _____

(Participant/Student)

Signed: _____ Signed: _____

(Investigator authorized representative) (Parental Consent for Participant/Student)

Witness: _____

Refusal for Participation in Research

I refuse my child's participating in research entitled: Effects of a Student Worldview on the Cognition of Human Origins

Date: _____ Signed: _____

(Participant/Student)

Signed: _____

(Parental Refusal for Participant/Student)

INFORMATIONAL FORM

(Printed on School Letter Head)

Hello, my name is Jeremy Ervin. I am a graduate student at The Ohio State University in Columbus studying to get my doctorate degree in Science Education. I would like to ask you for your help in finishing up my degree by participating in my research for my final project. The purpose of my study is to investigate how students' worldviews affect their learning of concepts in science. I will use the theory of evolution as the concept to investigate, since it is one of the most obvious areas in science where conflict may occur due to students' worldviews. I will not be engaging your child in any conversation as to the teaching of evolution or any specific worldviews, including any discussion of my own ideas or worldviews. The purpose of this study is not to delve into the controversy that stems around the theory of evolution, but to use the controversy as a means to understand how your child's worldview affects their learning.

Now here is a quick overview of the study, and then I will explain the study in greater depth. Your child that is in _____'s AP biology class will be asked to participate in the study. Only those that receive parental permission will be allowed to participate. Most of the study will not interfere with your child's class time, and there are awards given for participating. The Parental Permission Form (on OSU letterhead – 2 copies) will need to be returned by _____. Each student that returns the parental permission form (whether they are or are not participating in the study) signed will be given an award for his/her effort. Please keep one copy of the Parental Consent form for you. The students whose parent or guardian has granted approval for the research will participate in a preliminary interview session. Any information that is obtained in this study will be completely confidential. There will be no link between your child's name and your child's information. Also, _____ will not be informed of your child's responses, so it will not affect his/her grade in her class. The preliminary interview is composed of 4 questions about their worldview and science that may lead into other questions based on the your child's response. All interviews will take place in the science computer lab, which was designated by the Principal. The participants of the preliminary interview will receive another award.

From the consenting students, three of the children will be chosen to participate in the final phase of the research. This phase entails the use of the in-depth interview process as a means to allow the students to expound on their answers to the preliminary interview questions, and to verbalize their thought processes about learning. Again, this last phase will not interfere with any academic classes. This last phase should only take a few days with less than an hour each day to finish. All interviews will be audio taped, and again no connection will be made between your child's response and his/her name.

Please keep in mind that I will not be investigating your child's ability to learn or if they understand the theory of evolution, but rather investigate the effects of their worldview on their learning. From start to finish, this research should only take 12 school days with only a few minutes to a couple of hours of your child's time.

Feel free to contact Jeremy Ervin if you have any further questions or comments. ervin.62@osu.edu or (419)756-4659.

Thank you, Jeremy Ervin (Investigator)

APPENDIX B

SCRIPTED FIRST MEETING

Hello, my name is Jeremy Ervin. I am a graduate student at The Ohio State University in Columbus studying to get my doctorate degree in Science Education. I would like to ask you for your help in finishing up my degree by participating in my research for my final project. The purpose of my study is to investigate how students' worldviews affect their learning of concepts in science. I will use the theory of evolution as the concept to investigate, since it is one of the most obvious areas in science where conflict may occur due to students' worldviews. I will not be engaging you in any conversation as to the teaching of evolution or any specific worldviews, including any discussion of my own ideas or worldviews. The purpose of this study is not to delve into the controversy that stems around the theory of evolution, but to use the controversy as a means to understand how your worldview affects your learning.

Now here is a quick overview of the study, and then I will explain the study in greater depth. Each of you will be asked to participate in the study. Only those that receive parental permission will be allowed to participate. Most of the study will not interfere with your class time, but there are awards given to you for participating. The Parental Permission Form (show them the form) will be given to all of you and asked to return it within two days to _____. Each student that returns the parental permission form (whether they are or are not participating in the study) signed will be given an award for their effort that will be _____. The students whose parent or guardian have granted approval for the research will participate in a preliminary interview session Any information that is obtained in this study will be completely confidential. There will be no link between your name and your information. Also, _____ (teacher's name) will not be informed of your responses. The preliminary interview is composed of 4 leading questions that may stem into other questions based on the your response. All interviews will take place in _____ (an office designated by the principal) and will have the principal's approval. The participants of the preliminary interview will receive a free pizza lunch as an award. From these students, three of you will be chosen to participate in the final phase of the research. This phase entails the use of the in-depth interview process as a means to allow the students to expound on their answers to the preliminary interview questions, and to verbalize their thought processes about learning.

Now for greater detail of my study. Two days from now, I will pick up the returned permission forms from _____ (the cooperating teacher). Then on _____

(next available class period), I will come back into the class to schedule the preliminary interviews for all participating students and to hand out _____ (awards) to those that returned their parental permission form signed. My goal is to have these audio taped interviews done within 5 school days. At the end of each interview, I will let you know the day in which the free pizza lunch will occur, which is your award for participation.

Upon completing all of the preliminary interviews, I will then select 3 students. The three students will be contacted at the pizza party, and we will finalize the times for the remaining interviews. This process will require the three students to be involved in a few audio taped interviews that will be about one hour long, which will take place outside of class at the convenience of the students. This last phase should be completed within ten school days. After the final cycle, each of the students will be given a $5 certificate to _____ (the in-school restaurant) as an award for participating in this research. Do you have any questions? (Answer any questions)

Okay, here is the Parental Permission Form (Hand out the form & explain where to have the parent or guardian sign & what part of the form I need back.)

Thank you for your interest in my research, and don't forget to return these forms by _____ in order to receive _____.

APPENDIX C

BIOGRAPHICAL FORM

Directions: Please read the following items and circle the choice that best describes you.

- **Graduation Year: _____**
- **Favorite Class:** Math Science English Social Studies
- **Overall Grade in High School (GPA):**

  A B C D F
- **Typical Grade in Science classes:**

  A B C D F
- **Grade you think that you will get in your AP Biology class:**

  A B C D F
- **Grade you received on the chapter of evolution in your Biology class:**

  A B C D F
- **Number of times you went to church/synagogue/or other religious activity (in the last 3 months):**

  Never Once every other month Once a month Once every other week

  Once a week More than once a week

- **Write your religious affiliation/denomination in the space provide.** (If none, write "NONE.") _____

APPENDIX D

PRELIMINARY INTERVIEW

Thank you for your willingness to participate in this study. Please write your name only on the nametag, and read and follow the directions on the following pages. If at any time you do not wish to answer a question on the form, just skip it. If you have any questions, you may ask me at any time. Once you are finished with the survey, I will begin asking you some questions that you may freely respond to. Please do not talk with any of the ten selected about your answers until all preliminary interviews are finished. Even though I am audio tapping this interview, there will be no connection of your name to your responses outside of this room. Also, keep in mind that your responses will in no way impact your grade in your science class. If you are ready, you may begin.

Now that you are finished, let's begin with the first question, and please remember that none of your answers will in no way affect your science grade. If you do not understand any word or question that I ask, please let me know so that I may explain it better.

1. According to what you have learned in the science class, how did the Universe, earth, and living things come about?
2. According to what you believe is true, how did the Universe, earth, and living things come about?
3. Do you think that science and religion ever contradict? Explain why or why not?
4. What is science? What is not science?
5. Have you ever disagreed with something that is taught in your science class? If so, what would be the reason(s) for disagreeing with this information?
6. Do you believe that there is some supreme force or being that exists beyond our world? If so, how much impact can or does this supreme force or being have on our world?

Thank you for your time, and on _____ you will have your free pizza lunch for participating.

APPENDIX E

EDWARD'S FINAL NARRATIVE

I believe that there are plenty of things that science can't explain. I am a religious person, so I believe in God. Science is a way of explaining how something works, and religion is a way of explaining why it works. There is probably at least something in the world that transcends science, which can't be described in purely physical means. In fact, science has been sort of evolving to a point where it could accept ideas that are beyond typical scientific observations, like psychic abilities. Even if you go back to the beginning of time when the universe was created, science suggests that it may have begun with the Big Bang. Science has no idea as to why such an explosion would take place, so maybe God created the Big Bang, in which the Big Bang created the universe.

Belief in God does not necessitate that if you drop something that it won't fall to the ground. Certainly God could use the theory of evolution as a means of human origins. Even the official churches have agreed that the Bible could be subject to interpretation, especially when considering the Bible has been translated and changed many times. When the Bible says that He created everything in 7 days, maybe that's a metaphor or a mistranslation that means He created everything in 7 stages. It also might be just a prophet taking some poetic license.

It is difficult to determine if God has any impact on our life or nature, because if you can't prove the fact that He exists, then you can't really measure His impact. I

believe He oversees things in a general way, and makes sure the Universe is up and running, and everything works the way it is supposed to, but His meddling in the affairs of the Universe is kept to a minimum. My Mom is a big believer in angels, and she can name several times when she thinks there has been some supernatural intervention or something. There is only one situation that I personally know of, which can be verified at least in a general sense. Even though I think this intervention is possible, it does depend on how you interpret the situation, which may be explained by supernatural or by some other occurrence. It all depends on however you want to look at it.

Even still, I try to live my life by the Bible because I think, at the very least, it is very good advice. I don't feel that I lose anything by believing in the Bible. I can still believe in science; I can still believe in any other sort of superstition or supernatural influence on the earth without conflicting with the Bible. I think for the most part anything in there can be true, but sometimes you have to either interpret it more or not interpret it at all. People like the Klu Klux Klan, and other stupid hatred groups, basically ignore the entire message of love and tolerance in the Bible by taking one quote a mile out of context to support their views, and then accept that as the law.

The problem with interpretation is that anything can be interpreted anyway you want. Some read *Winnie the Pooh* stories, and interpret them as a metaphor for communism. Some say that the movie *The Matrix* contains Christian messages, which to a point that could be true, but really it's just the way you interpret it.

When one considers the interpretation of scientific experiments, there is a limit that one can stretch before it breaks under the pressure of data. But still you see it all the time. For example, scientific studies by the medical community has thousands of

examples of absolute proof that cigarettes cause cancer, but the cigarette companies have managed to skew the data to some point where it casts some reasonable doubt on the matter just to cover their rear-ends to keep selling their products. Their facts are valid for a certain definition of the word because, in the very direct sense, they're true, but it is really only a small picture of the whole truth.

For the most part, I think that the scientific community is filled with mostly objective people who like to form their theories after the evidence, rather than before. They have the proper training to make such observations, so I accept them as truth, but I always try to keep an open mind to alternatives and possible biases that influence their findings. I've read papers written by evolutionists who basically attempt to skew the facts in their favor.

If I am being taught information that there is an opposite view to, let's say the gravitational theory, then I should be taught the most prevailing view, but also keep an open mind to the alternative. The best way to keep an open mind is to learn everything you can about basically everything so that you can compare. Simply saying I don't want to learn about that because I would rather believe this, is pretty ignorant because you will really never know what it is you are believing and how it conflicts with what you don't want to believe.

Belief can be anything from a mild superstition or hope to one of those cast iron beliefs that will be with you all your life. I think beliefs are based on a combination of faith, common sense, observational evidence and open-mindedness. So, when I am being taught the theory of evolution in a classroom, I have no qualms about being taught it, because the best thing I could do is to learning as much as I can about other ideas. I by

no means think that my religious belief and the theory of evolution are mutually exclusive. I think that they could interact, intersect, and meet at some point. In short, there must be some sort of compromise.

In some sense, I see some conflict between science and religion, but it gets complex. Like I said, there are many different ways that you can interpret things. You might accept the fact that Jesus Christ left the earth 2,000 years ago or you might not believe it at all. You might believe something different. For instance, the Muslims believe he existed, but that he was a prophet. The Buddhist also believes that he existed, but that he was a person who obtained a nirvana and all sorts of other things. In the scientific community, some people believe he didn't exist at all. Then other scientific people think he was just a normal person. Others believe he was some sort of gifted person, and might have had some sort of abilities that weren't normal. I believe the standard religious definition that Jesus was the Son of God, saved us all, but I also like to keep my mind open to any other explanations there could be.

Sometimes people are too afraid to look closely at their religion because they're afraid that they'll discover a scientific explanation. Then other people are too afraid to look at the universe scientifically because they're afraid they'll find something that can't be explained by science, which might only be explained by religion.

Scientific evidence could cause me to redefine my beliefs, to reconsider them, to interpret them in a slightly different way, but I really don't think that there could be enough data to prove that the whole think is false, and that there isn't anything out there. The entire point of faith is that you believe in something that you have no evidence of. For instance, I believe a table exists, because I can see it and feel it. I believe in God

simply out of faith. I think He's out there but I have no way of observing or experimenting to determine if this is true. To suggest that anything that appeals to the five senses could question anything that doesn't, really doesn't make that much sense.

So when it comes to ideas that both my faith and science has an explanation about, like the question of human origins, I would like to think that there is some compromise, but in this case the two are particularly stringent. The Bible basically says that God put two humans on earth. While evolution says that there was something that happened over thousands of years, from rodents to monkeys to creatures from *2001: A Space Odyssey* to us. Also, the two are mutually exclusive and it's really just a matter of personal choice what I believe. In general, I believe the Bible's explanation, that God created them, but I also have seen plenty of evidence to support the contrary. I like to keep an open mind and constantly search for a compromise.

I would be willing to update and alter my beliefs based on more scientific data. For instance, in the Bible it says Adam and Eve were created. It doesn't describe them. Perhaps they were Neanderthals. Perhaps they were some sort of subhuman that hadn't quite achieved our level and would continue to change over time. It really doesn't give enough details to be sure of what happened. It's all a matter of interpretation. The facts are there and the stories are there. It's just a matter of finding a way to sync up the two.

If both sides are willing to make some compromises and accept some things that they don't have ample evidence of—maybe if the scientific community would accept that maybe there are things that we can't see and can't touch but they are nonetheless real. Maybe if the religious community could say, all right, maybe Adam and Eve were quite

fully humans yet, maybe there were some sort of species that changed a little bit more into us, then I think some kind of common ground could be found.

As I gain more scientific understanding, I accept the fact that there could be inconsistencies in my religion, but then there are also countless inconsistencies in the scientific community. When I was little, too young at the time to understand, I basically accepted anything I was told. I believed in evolution, and I believed in the tooth fairly. Both were equally acceptable to me because the explanation of where humans came from was the same as explaining how the quarter got under my pillow. Both explanations were just as good as any. One could believe that Santa Claus was just a person in the mall, or one could believe the kid who said he was real because he saw him one year. It is just a matter of acquiring enough information to form your own opinion.

Throughout my education I have never had any conflict with what I was being taught, even with the theory of evolution. When I was first taught evolution, I was 8 years old and my biggest problem was figuring out how I was going to get my parents to buy me a new action figure, so I didn't really have many conflicts. Even back then, as I also do now, I liked to look at one idea and the other idea to find some way in which both could be true. I am open to learning about anything because I always think you should be open about learning new things.

All science is valid and so are all religious beliefs because even things as obvious as the theory of gravity are still just considered theory. They're just what people think are going on and as long as they work in a practical way such as the ability to use the theory of gravity to calculate the rate at which something will fall, then it's a useful skill and it works.

Now I consider the theory of gravity in some ways to be more valid than the theory of evolution because you can observe the theory of gravity in action, when you drop something, it will fall. There is sufficient evidence for the theory of gravity, so I believe in it. I consider it perfectly valid as good of an explanation as any. I see no evidence that suggests that it is not true, so I might as well believe that it is true. I still consider the theory to be valid because it works under what we consider to be normal circumstances on this planet, even though in outer space such theories sometimes don't have the effect they do on earth. Perhaps our kind of theory is wrong or we just have the basic idea right and there are some variables we aren't considering. Perhaps there's just some completely other theory in which we haven't yet considered.

Where with evolution, something that happens over millions of years can't be observed through purely physical evidence, unless you examine fossils and even then a lot of guesswork is involved. For instance, when you look at the skeleton of a dinosaur and the skeleton of a bird, one notices similarities in bone structure between them. There certainly is some evidence that the one may have evolved from the other, or at least had a common ancestor, but evidence that supports that view is not proof. Maybe some animals did come from other ones. Maybe other ones came spontaneously. Maybe God did create bacteria and let them evolve. Or maybe He did just create the Garden of Eden in 7 days like it says in the Bible. Anything is valid. For example, an interesting article suggests that the Bible might have been on to something when it discussed the way God created the earth in the book of Genesis. It says that He started out basically with the simplest things like creating the planet and then creating very tiny creatures and then creating plants and animals, and them more complex animals, then finally humans. The

Bible's idea syncs up almost perfectly with the theory of evolution, but the Bible was written thousands of years before that theory existed. Maybe the author had a lucky guess, or maybe he had his own theory of evolution that he chose to express in the creation of Eden, or maybe the Bible is true and he really was a prophet who received some kind of a message from a higher being. Whatever the case may be, I do not see any reason why science and my beliefs have any conflicts with each other, because all ideas are possible and open for interpretation.

APPENDIX F

RUEBEN'S NARRATIVE

I believe in God and He does everything for a reason. He is in charge of everything that goes on on earth. If I get in a car wreck, that is His way of saying that it is my time. I pretty much accept it. He is pretty much in charge of everything that goes on. I think he is above everything.

Some things you are in charge of and other things you are not. For example, a person getting in a car accident could have made a decision to drive drunk and therefore had the wreck, but then again the accident could be God's doing. I guess you can say that there are things that you have in your control and there are things that are in His control.

God not only has some influence on human life but also in nature. In nature everything goes through a process. In spring, many plants bloom. Nature definitely has an impact on this process, but God also allowed it to occur. He's in charge of allowing it to rain, when a plant will bloom, and how it's going to bloom. There have been years when God has determined that this year is going to be a dry spell, which affects the natural processes.

As I learn how a flower goes through its life cycle, I always think about the God aspect, and I accept what is in the textbook as being an accurate description of what really does occur in nature, because the scientists that investigated it actually observed the plant's life cycle.

Science is changing all the time. I think it's evolving. Everything is changing. New things are being discovered. For instance, the rainforest, there are insects that we haven't discovered that are evolving. There are always things that are new. This is evident in the taxonomy. Everything probably started with one bio and then everything just branched out into several different species—it has just evolved.

However the origin of humans is a little different. The evolutionary theory does not provide the adequate explanation. I don't believe in the blob and that everything evolved from a lot of cells. I think that God put Adam and Eve here for a reason, and that everything evolved from them. I know all organisms are related in some way but I guess it makes more sense to me that Adam and Eve was the beginning point for humans, which produced all the humans that are here and then also the primates that are similar to us. I mean they kind of evolved from us, but then there were things way before Adam and Eve such as insects.

Since God placed Adam and Eve here and humans branched out from them by reproducing and their children reproducing, then there would be similar makeup of blood type, DNA, other things. Of course, you're going to have incest with children of incest, and as a result you're going to have messed up chromosomes and stuff like that. That's why I see other primates coming from that process of reproduction of Adam and Eve. Then ethnic groups or races occur by the different makeup of people. For instance, African Americans and whites may be different because in one of the stages one human maybe had darker pigment in their skin.

In school, I was taught that humans evolved through a process of changes. Even though I do not agree with this concept, if I was to answer a question on a test, I would

answer with the accepted idea that was found in our science textbook. All through high school I had to accept what is in the textbook. I might have had my own theories on things, but that isn't going to help you take the test.

It doesn't bother me that I am required to learn things that I don't agree with. I'm pretty much left-brained, so everything needs to be black and white. So if the book tells me something, that's what I learn. I don't necessarily have a problem with learning things that I disagree with because that's what I need to learn and so, therefore, I learn it. There is no difference in how I learn things that I do not disagree with compared to the things I do agree with. For example, I learned the concepts of the theory of gravity the same way that I learned the concepts of the theory of evolution. Success in high school has always been a major concern of mine, and now that I am the valedictorian of this year's graduating class, I have seen my goal achieved.

There are definitely conflicts between science and religion, and I definitely would say the evolutionary thing would be the biggest one. When we have talks about evolution in our science class, in which most of the class doesn't believe in, the students would go off on the teacher. Students would come out of class angry, and say that the teacher has no right to say things like that, and things like that should just be kept to oneself.

For me there it is not a big deal to learn about the evolutionary theory even if I do not agree with it. I guess everything I learn I just accept. People that think this is a bigger issue have a bigger conflict with it. They would be the ones that would definitely speak up against the teacher teaching it, but that wouldn't be me though. I just accept what I am taught, and apply it to everyday life. I don't get upset or anything. I don't mix

my beliefs with what I am being taught in school. I don't really have a thing about that kind of thing. I just keep science and my beliefs separate.

What I am taught in science does not effect my religious beliefs at all. But what I learn in science does affect my life. Everything I do is affected by science. The information I gain from science helps guide my decisions, even the simple things that I do are influenced by science. For instance, when someone builds a house and wants to plant things in a low area. You are not going to plant any plants in that area that can't grow in a wet area, because it will die. You are going to put plants in the house by windows to get sun, and give it the right amount of water. Another example is what I learned in microbiology this year, when we swabbed parts of the body to see if we could culture any bacteria. We swabbed under our arms and we didn't get any bacteria growth because we all wear deodorant, which kills the bacteria. Things like that are all science related by the knowledge I have obtained through the years.

Even though God has a lot of impact on this world, He still allows scientists to come up, by doing some studies, with information that goes against Him, because He has let everyone have different opinions. He did that for a reason and that's why we have different thoughts or whatever we're learning and in some aspects might not be right or some might be right. There are so many different things that we can accept and believe.

The reason I don't accept the theory of evolution was the means by which humans originated is because what I've grown up with and been taught since I was a child, which is from a religious aspect. So that's something I can believe at home, but when I come to school, I'm going to believe what the textbook says or I'm not going to get a good grade on a test. I have to accept it. I just put the information that I do not agree with into my

long-term memory, because I will need to recall it when I have the final or when it comes up later in life. For instance, I'm going to go study a biology/pre-med major at Johns Hopkins in Baltimore and half the stuff I'm going to learn there, I may not believe, but because the textbook or the professor says it, I will believe it, no matter what.

Even though I have a problem with what is being taught, I consider my grades, which are so important, and then learn what they are trying to teach me. It really doesn't affect me that much. When I go to college, I probably will handle this issue the same way I handle it now. I'm going to accept what the professor is teaching.

It sounds bad that I don't have any problems when I am learning about issues that conflict with what I believe, because I am not defending what I believe in. I think it should affect me more than it does.

My view of the Bible is that everything in it is accurate. I accept everything that's in it. I'm an easygoing person and pretty much accept everything—that's why I was pretty much voted most gullible this year in the whole school, because I just believe everything. If I come across something, I believe it. I guess I accept everything. It's kind of easy to convince me of something.

The only thing I think is inaccurate in the science textbooks would be the ideas of human evolution. I do not have any problems with the other things because those are things that I have seen myself. So back to the nature thing, I have seen plants go dormant in the winter, and then in the springtime bloom again. I think that these important ideas are how things are evolving right now, instead of what has happened in the past.

APPENDIX G

SUZANNE'S NARRATIVE

I believe that there is a supernatural being that exists beyond our Universe, which is God. I grew up in church and God is everything to me. Things in life happen for a reason, and He is the reason for it happening. He's like the writer of the story and we are the characters in His book. We're God's masterpiece; the earth is also His masterpiece. That was what I was always taught; that's what I believe. See, it's my decision to follow Him. I could go down another path; that's when I decide to open my heart to Him and tell Him, "I will follow You." He loves us all, and I know He's going to be with me, and I am striving to be like Him. My goal is to be like Him.

God's impact on us is evident by how He guides us. When I am faced with temptations, and if I choose to follow His path, He will lead me to something better.

Also, if I pray, He can have a direct impact on someone. It's not like I can call him from a phone to talk to Him, but He still does have direct impact, if He decides to answer my request. God can heal people, which is evident because the doctors have no idea how the person got better. For example, when people get cancer. Some cases the doctors say that there isn't a way to get rid of the cancer. Then prayers might be offered for this person with cancer, and then completely recover. It is obvious to me that it was a

miracle or a blessing from God because nobody else has an explanation for it. So God changed the natural course of what should have occurred and impacted that person.

Another way that God has impact is on nature. For example, scientist try to come up with reasons how the Grand Canyon was formed, but nobody is 100% sure. So they try to come up with a hypothesis to figure it out, but nothing really proves that that is how it was formed. So, the only explanation that I can trust is that God had some impact on the formation of it. It's probably an act of God.

Now, I don't want to give the impression that science cannot explain things; because there are some things that science can explain, like the cell and cell divisions. With cell division you have natural process that will occur. Although God could have impact on cell division if He wanted to, He typically does not interfere with natural forces. He doesn't one day just out of the blue say I'm going to change it, because it's His creation and His masterpiece. He only has a reason to change it when He wants people to see that He exists. He wants people to understand His creation, and so by changing the natural process would confuse people that are trying to know how it works.

Science is a way of knowing. Like studying how things work, and how everything connects. You can use the scientific method to experiment and know certain facts about nature. Facts are something that you know because you tested them over and over again, and have proved that they are true. However, you need to realize that before you're going to learn something that not everything is a fact, because science shows that ideas are going to change based on new information. Realizing that what we know might come together at some point in time to not change, which then you can grasp that. For instance, maybe a plant had a mutation when it produced one little seed. If that seed

survived, it survived for a reason. Maybe it is adapting to something and it's also going to produce more of those mutants just like it. So maybe it's coming up with a new species to adapt to what is happening to that specific organism on earth. It's changing and adapting for a reason.

Now my religion is similar to science in the way that it too is a way of knowing things, but it is based on faith not experimentation. I believe that the Bible is accurate and contains truth. The Bible is more or less like a Christian's textbook to life. If I have any questions about life, then I can read the Bible and find the answer, because the lessons in the Bible are going to reoccur, so I will be able to find guidance by the principles that are in it. The Bible has never been revised or corrected because it doesn't have any errors in it.

Most of the time the truth that I find in the Bible agrees with the truth found by science, but there is one area that they do contradict, and that is in the areas of evolution. Let's take human origin as an example. In the Bible it says that Adam and Eve were the first humans. Science teaches the natural process of starting from a lower species, which had to go through changes to eventually have humans. This natural process doesn't make any sense to me. Why couldn't God just make Adam and Eve to begin with and let them produce what we have today? Science and my belief in human origin don't fit together at all because one says that humans were created and the other says that humans got here through many changes.

When I am taught about the theory of evolution, I just listen and take notes like I always do. When the test comes, I write it down whatever the teacher says in class. If I am asked my opinion, I tell them what I think is the truth. If I agree with the concept

being taught, then I think about it more in depth and I participate in classroom discussions about it.

It doesn't really offend me to learn about other ideas or anything; it's just, like, okay, whatever. If I have to answer questions on any test, I just choose what is considered the most accepted theory—the Darwinian theory. I don't really believe it, but I guess it's a possibility. It's just another side to a story. You have this side of the story and you have my side of the story.

Knowing what other people think is actually really a good thing. Like, people always say listen to your enemies because they tell you your faults. That's kind of like the same thing. You may not always agree with somebody but listening to his or her side of the story isn't going to hurt you. It can help us understand where another person is coming from; maybe it can help you explain something that you have trouble with or learn their little piece to help put your pieces together to come up with something new that you didn't know before. Knowledge is power.

I really try to not let the teaching of evolution bother me because I know that they are teaching because they have to. So I just sit there and I don't really apply it to anything to my life. I'm kind of like a machine. I take it in. If teachers don't force it on you, and if they don't think that their way is the only way, then I don't get upset. I only remember one time ever really getting angry with a teacher, not just because of what they were teaching, but rather how they were teaching it.

When I am studying something that I disagree with, I just flip the card over to see if I was right, but I don't think about it. But if I do not agree, I just write it down and forget about it. When I read the question and I know the answer and I just write it down

and I don't think about it. I don't think about it deep, because I just don't care, and I will just forget about it later. Even though I disagree with the theory of evolution, I still understand the ideas behind it. I have always received an A in my science classes, no matter if I agreed with it or not. It is more difficult to learn things that I don't believe in because I don't have the same kind of passion and motivation to learn it as I do everything else.

The main reason that I disagree with evolution is because ever since I was little I was taught about the Bible. Everything that I believe in now does not agree with the theory of evolution, so I don't believe it. My faith in God and the Bible is a lot stronger than some theory of evolution, and no amount of proof will ever get me to change my faith. No other topic, whether in science or in any other subject, do I have this strong of beliefs about. That is why only in this area of evolution does science and religion conflict with each other. There are people that think evolution is bad because it goes against the Bible, and the other extreme says that the Bible is just made up and all we have is science to explain things. There comes a point that they don't fit together like people hope they would.