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INVESTIGATING GENDER DIFFERENCES IN STUDENT VIEWS OF NATURE OF SCIENCE, UNDERSTANDING OF EVOLUTION, RELIGIOUS BELIEFS AND ACCEPTANCE OF EVOLUTION

by

DANIELLE NICOLE CARLTON

Presented to the Faculty of the Honors College of
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I would like to thank my parents and boyfriend for giving me moral support during this project. Without their love and encouragement, I would have felt lost and defeated when difficult times arose. However, I was able to develop a project that interests me and reflects my areas of study, as well as finish and present my findings.

I especially would like to thank God for providing me with the opportunity to work with Dr. Cavallo and Dr. DeVito, the strength to conduct this research project, and for guiding me throughout this process.

April 11, 2014

ABSTRACT

INVESTIGATING GENDER DIFFERENCES IN STUDENT VIEWS OF NATURE OF SCIENCE, UNDERSTANDING OF EVOLUTION, RELIGIOUS BELIEFS AND ACCEPTANCE OF EVOLUTION

Danielle Nicole Carlton, B.A. Biology

The University of Texas at Arlington, 2014

Faculty Mentors: Dr. Ann Cavallo and Dr. Jill DeVito

Evolution is a unifying theory in biology and provides foundational knowledge needed for future learning in the subject. However, acceptance of evolution may be challenging for students due to differing views of nature of science, understanding of evolution, and/or extent of separating evolution from religious beliefs. Further, males and females may vary in their views of the nature of science, understanding of evolution, religious beliefs, and/or acceptance of evolution; and such potential differences should be considered for all students to successfully learn this important scientific theory. Therefore, the research questions of this study were: 1) What are descriptive patterns and differential shifts from pre- to post-evolution instruction (time)

between male and female students' views of nature of science (NOS), understanding of evolution (UE), religious beliefs (RB), and acceptance of evolution (AE), and the interactions between pre- and post-scores (time) and gender? 2)What are interrelationships among male and female students' views of the nature of science (NOS), understanding of evolution (UE), religious beliefs (RB), and acceptance of evolution (AE) pre- and post-evolution instruction? 3)What is the predictive influence of male and female students' views of the nature of science (NOS), understanding of evolution (UE), and religious beliefs (RB) on their pre- and post- instruction acceptance of evolution (AE)?

Students (N=81) were given pre-evolution instruction tests and questionnaires measuring their views of nature of science, understanding of evolution, religious beliefs, and acceptance of evolution. A four week active, inquiry-based instructional unit on evolution was experienced by the students, followed by the administration of the same questionnaires as post-tests. Results indicated significant positive shifts in understanding of evolution from pre- to post-instruction. There were no significant correlations among pre-instruction variables for females; nature of science and acceptance of evolution was positively correlated for males. Post-instruction religious beliefs and acceptance of evolution were correlated, and religious beliefs significantly predicted acceptance of evolution for both genders. Regardless of the learning achieved from the instructional unit on evolution, students who tied religion to evolution accepted evolution less.

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CHAPTER 1

INTRODUCTION

1.1 Problem Statement

Evolution is a unifying theory in biology and provides foundational knowledge needed for future learning in the subject. Therefore it is important that students acquire sound understandings of evolution in high school. However, research has reported that students have difficulty accepting evolution as a sound biological theory based in evidence; difficulties that may interfere with future learning. These difficulties in accepting evolution may be due to a variety of factors; however, those that stand out in the literature include: students' views of the nature of science as tentative or dynamic, acquisition of sound understandings of evolution, and strongholds in religious beliefs that are adverse to evolution. Furthermore, males and females may hold differing views of the nature of science, understandings of evolution, and/or show differential influence of religious beliefs with respect to accepting evolution. This study aims to better understand differences between males and females in their views of the nature of science, understandings of evolution, religious beliefs, and acceptance of evolution. The study will also contribute to the current literature on learning evolution by exploring factors that may influence male and female students' acceptance of evolution before and after instruction, thereby gaining better understanding of the potential influences of instruction on helping students understand this important unifying theory in science.

1.2 Significance of the Study

The results of this research could help science education by providing insight as to how male and female students view and understand science and evolution. The study may inform educators on ways to improve the methods of teaching science and evolution in the classroom. The better teachers and educators can understand their students, and how males and females may differ in their learning and acquisition of understanding, the more effective their methods of teaching will become. The integration of specific teaching strategies that address potential gender differences could be incorporated to effectively communicate the concepts and develop students' critical thinking.

It is well documented that evolution is a controversial topic to teach in K-12 schools, due to strong religious opposition. This study will reveal information on the extent to which students tie acceptance of evolution to religion and may contribute new and useful information to this issue. Further, the results of this research may help inform teachers on how students view nature of science (NOS), which is a factor that may impact understanding of science, future learning in science, and career decisions. With knowledge of how students view nature of science, teachers can design instruction to help their students learn science in ways that are consistent with the inquiry nature of the discipline. If students better understand nature of science and have opportunities to experience it in their classrooms, they may gain interest toward choosing a science career path. Learning more about how males and females may differ in their understandings and views of nature of science can help teachers implement strategies

that will appeal to all students, and help to bridge the gender disparity that currently exists in science courses, and in scientific professions.

CHAPTER 2

LITERATURE

2.1 Literature Review

This study focuses on factors that may influence teaching and learning evolution, and is based on previous research. The factors important to this study include views of the nature of science, religiosity, understanding of evolutionary theory, and acceptance of evolution.

2.1.1. Religion and Evolution

Surveys on the degree of acceptance or rejection of evolution and other topics in science were collected and analyzed from freshman and seniors at a university in Brazil. A majority of the population is Roman Catholic, and the study produced many interesting results about the theory of evolution. The students tested were all majoring in a discipline of science and had received instruction on most, if not all, of the material in the surveys. A majority of the students agreed with the basic statement "I accept evolution and I believe this does not discard the existence of God," while the least popular statement was "I do not accept (evolution) because I accept the literal truth of a religious creation as described in the Bible" (de Souza, de Carvalho, Matsuo & Zaia, 2010, p. 111). It was found that topics on the age of the planet, the universe and the process of evolution were significantly affected by the religion of the student ($p < .010$) (de Souza et al., 2010). The lowest acceptance was from Christian students of non-

Roman Catholic affiliation. Another factor found to have a significant effect on the student's acceptance or rejection of these topics was the level of education of the mother, while the father was a much smaller indicator (de Souza et al., 2010). Family income and the level of education of the parents influenced the extent to which the students trusted science, while parental income, parental education and religion all influenced how certain students believed science is about evolution and the big bang theory (de Souza et al., 2010). It seems that environmental factors, such as religion and family situations, impact students' beliefs and understanding of science.

2.1.2. Religion and Education

Some of the issues that exist between religious groups and institutions that educate on topics of evolution are due to the differences in goals between the two institutions. Scientific discoveries, which are often used to benefit society, can be seen as "promoting alternatives to divine truths already specified in scripture," as exemplified by the theory of evolution and its contradiction of the Bible's account of creation (Darnell & Sherkat, 1997, p. 308). Some religious groups and denominations do not promote education, and as a result, data has indicated that "conservative Protestants have lower educational aspirations" (Darnell & Sherkat, 1997, p. 310). Similarly, grade-point average in high school, enrollment in college-preparatory classes and educational attainment are all negatively affected (Darnell & Sherkat, 1997). Parents also have a role in their student's level of education. If the parents are very religious and adhere to the Bible's description of creation, they will indirectly influence their student's curriculum and beliefs. The parents' education level, income and career

may also affect their children's schooling and beliefs in evolution, because these associations can influence and change the religious beliefs of adults (Darnell & Sherkat, 1997).

2.1.3. Religion, Education and Gender

The educational gender gap is a real concern for countries all over the world. There is evidence that increasing the education of females will help diminish the gap, and also improve economic growth and quality of life, especially in third world countries (Norton & Tomal, 2009). Education can lead to these improvements because young girls and women are then able to enter the work force, they desire to marry later in life and wait to start families, their level of nutrition increases and overall mortality decreases. One explanation for the education gender gap may be the role of religion in daily life and how it influences gender roles. Studies have investigated different religions and their impact on female education level and wellness. Many undeveloped countries promote large families and have traditional gender roles that are also supported by their religion and/or authoritative institutions (Norton & Tomal, 2009). On the other hand, more developed countries tend to lack these traditional gender roles, but occasionally values and cultural norms still occur. Regions tend to show trends in these areas as well. For example, Islamic and Latin American countries have higher levels of gender inequality and are more likely to enforce and promote it (Norton & Tomal, 2009). Since religion affects the caste system in India, enrollment rates have been impacted there as well. The castes influence a "family's ability to provide education" and tends to promote male education over female education (Norton &

Tomal, 2009, p. 967). Research in the US has determined that how religious groups promote education, through the parents, can affect education rates. For example, "Jews have the highest educational attainment" due to small family size and greater ability to invest in the child's schooling (Norton & Tomal, 2009, p. 967). Although it varies by nation, most women lack a formal education, and there are higher percentages of males who have primary, secondary and higher levels of education (Norton & Tomal, 2009). Studies have shown that urbanization, British colonial heritage, greater labor force participation and lower mortality rates increase the educational level of females (Norton & Tomal, 2009). Catholic and Hindu adherents have a negative effect on secondary educational attainment (Norton & Tomal, 2009). Buddhism and Protestant adherence positively enhances education of females, but ethno-religions and Muslims had the worst effect on female education (Norton & Tomal, 2009). Overall, Muslim and Hindu groups produced a larger gender gap and lowered female attainment because they increased the proportion of uneducated females (Norton & Tomal, 2009). The study concluded that some religions do stunt female education, and that there is not enough evidence to conclude that secularization enhances female education (Norton & Tomal, 2009).

2.1.4. Evolution and Scholastic Achievement

It has been shown in one study that "students who accepted evolution earned higher final grades than did students who accepted creation, by an average of one full letter grade," and the results were significant ($p < .05$) (Ingram & Nelson, 2006, p. 9). As a result, it is believed that there are major consequences for trying to learn biology if

evolution is not accepted. However, in another study the students who accepted evolution only had slightly higher grades than those who did not; therefore, a high grade may not always require acceptance of evolution. Due to varied results, this finding may indicate that the relationship between achievement and evolution may depend on the type of instruction being administered and/or the group of students being taught and tested.

In a study completed in the Midwest, sixty community college students were surveyed before a course on evolution, and only twenty-eight of the sixty completed the post-instruction survey (McKeachie, Lin, & Strayer, 2002). The lower number was a result of students dropping the course, either from confliction with their personal beliefs and/or from low academic standing in the class. Based on pre-test results, students who did not initially believe in evolution "were more likely to drop the course or fail" (McKeachie, Lin & Strayer, 2002, p. 190). It was also found that creationists did worse in the class than those who accepted evolution, but they still passed. In the study there were three students who remained creationists throughout the course, and it was discovered that they were more anxious, had lower motivation and were more likely to memorize the materials than try to understand the concepts (McKeachie, Lin & Strayer, 2002). In this particular study, it seems that the topic of evolution makes it difficult for those who do not accept it to perform as well as those who do accept it. It also led to many students dropping the course all together.

2.1.5. Students' Beliefs

There was an increase in the number of students who accepted evolution and a decrease in the number who accepted creationism after taking a course on evolutionary theory (Ingram & Nelson, 2006). Students who indicated themselves as being "undecided" on the topic of evolution were more likely to change their beliefs than those who accepted or rejected evolution before taking a course. Most of the students who changed their beliefs, and were initially undecided, accepted the theory instead of rejecting it (Ingram & Nelson, 2006). There is also a tendency for upperclassmen, or students more advanced in their education, to accept evolution. It has also been found that students might have reservations about identifying themselves as "evolutionists" for fear of being ridiculed or the idea that accepting evolution would mean that they would have to deny God's existence (Ingram & Nelson, 2006).

2.1.6. Teaching Evolution

The theory of evolution has been a debated topic in the educational system for decades. While there is societal controversy about whether or not evolution should be taught in the classroom, scientists agree that it is a unifying theory based on evidence and should be presented as such (Cavallo, White, & McCall, 2011). In regions where evolution is taught, teachers often face outside pressures which lead them to speed through the evolution unit, neglect human evolution and/or downplay the theory all together (Berkman, Pacheco, & Plutzer, 2008). The way students understand and/or accept evolution is often influenced by worldviews and religion. Many students have issues with accepting the theory because it contradicts their views of the world

(Schilders, Boersma, Sloep, & Peled, 2009). As a result, teachers may need to teach the concept separate from religion and worldviews, while allowing the students to believe what they want and respect those beliefs (Schilders, Boersma, Sloep, & Peled, 2009). On the other hand, some think creationism and intelligent design should be taught alongside evolution in science classrooms, as alternative ways of thought.

Some studies have shown that instruction on evolution does increase the number of students accepting it. The level of change varies by study and the variables involved. In one study, there was a small increase in acceptance, but a "positive change toward evolutionary conceptions regarding human evolution and other tenets of the theory" (Ingram & Nelson, 2006, p. 18). A possible explanation for this increase was that the instruction was solely on evolution and it lasted one semester, while many high schools may spend a week or less. The question of whether teaching evolution in public schools would change the beliefs of students is valid; however, it is believed that short lessons on evolution would not alter the beliefs of very religious students (Ingram & Nelson, 2006).

2.1.7. Teaching Science

Nature of science (NOS) is described as the process by which scientists gather data and evidence to explain the world and how it works. Nature of science represents a specific "way of knowing" that is based on scientific experimentation, and where new findings may support or change existing theories and understandings about the natural world. Nature of science is the framework for science and all of the knowledge that it encompasses, including how it is defined and understood (Cavallo & McCall, 2008).

Research has indicated that how students perceive nature of science and scientific theories impacts how they respond to the theory of evolution and whether or not they accept the theory. Two opposing views of nature of science have been identified in the literature, in which students view nature of science as ever changing and tentative, or as authoritatively known, unchanging and the "truth" (Abd-El-Khalick & Lederman, 2000; Cavallo & McCall, 2008).Thus, some students view science as constantly changing and being altered when new information is discovered, while others view science as solid facts that cannot be changed and have been "proven" as such. These divergent beliefs about nature of science may impact how the students learn and understand science content and processes.

2.1.8. Gender and Science

Women are underrepresented in science, technology, engineering and math (STEM) fields of study and career paths (Lauer et al., 2013). The phenomenon of women leaving STEM fields at various stages is called the "leaky pipeline" (Lauer et al., 2013). Research indicates that the effort that women make in these fields, along with their successes, are not as celebrated as that of male students and professionals (Muller et al., 2005). Some people, including the President of Harvard, believe that women have lower scores in science subjects because of genetic differences, while others think expectations placed on these women influence how well they perform (Muller et al., 2005). Evidence from standardized tests have shown that gender gaps in performance in these subject areas may be the product of the test taker's "perception of their gender roles and the perception of tasks as stereotypically masculine or feminine"

(Willoughby & Metz, 2009, p. 651). It has been suggested that gender cues from the questions on standardized tests may be at fault as well (Willoughby & Metz, 2009).

2.1.9. Gender and Religion

Research has shown that women take part in religious activities more often than men, and the differences of gender orientation may be the leading factor (Simpson, 2008). The variation in religious participation may be attributed to traditional gender roles as well (Simpson, 2008). Women are described as more nurturing and relationship based, while men focus on goals and success (Simpson, 2008). This may explain why women are emotionally involved in their faith and deem it as a "relationship with God," while men use the term "set of beliefs" (Simpson, 2008). These differences between men and women's religious activity could explain a variation in the data (if any) in acceptance of evolution as a theory.

2.2 Purpose of the Study

The purpose of this research is to explore and better understand if males and females differ in their views of nature of science, the extent to which they may dismiss evolution due to religious beliefs, understandings of evolution, and level of acceptance of evolution. The study will explore possible gender differences in any shifts that may occur in views of the nature of science, religious beliefs as tied to evolution, understandings of evolution, and their acceptance of evolution from before to after an instructional unit on evolution. The study will also explore the extent to which these same variables predict acceptance of evolution.

2.3 Research Questions

The specific research questions to be addressed in this research are the following:

1. What are descriptive patterns and differential shifts from pre- to post- evolution instruction between male and female students' views of nature of science (NOS), understanding of evolution (UE), religious beliefs (RB), and acceptance of evolution (AE), and the interactions between pre- and post-scores (time) and gender?
2. What are interrelationships among male and female students' views of the nature of science (NOS), understanding of evolution (UE), religious beliefs (RB), and acceptance of evolution (AE) pre- and post-evolution instruction?
3. What is the predictive influence of male and female students' views of the nature of science (NOS), understanding of evolution (UE), and religious beliefs (RB) on their pre- and post- instruction acceptance of evolution (AE)?

2.4 Null Hypotheses

Research Question 1

H_0 – 1.1: There will be no significant shifts from pre- to post-evolution instruction in nature of science (NOS), understanding evolution (UE), religious beliefs (RB), and acceptance of evolution (AE) for the group.

H_0 – 1.2: There will be no significant differences between males and females in NOS, UE, RB and AE pre- to post-evolution instruction.

H_0 – 1.3: There will be no significant interactions between pre- and post-evolution instruction (time) and gender for NOS, UE, RB, and AE.

Research Question 2

H_0 – 2.1: There will be no significant interrelationships among the pre- and post-evolution instruction variables of NOS, UE, RB, and AE for males and females.

Research Question 3

H_0 – 3.1: Students' views of NOS, UE, and RB will not significantly predict AE pre- and post- instruction for males and females.

These null hypotheses will be tested by statistically analyzing the data from the pre- and post-assessments and between males and females in this study.

CHAPTER 3

METHODS

The sample consisted of 81 ninth grade biology students. There were 37 males and 44 females in the sample population. Ethnic distribution of the sample was 90% Caucasian, 5% Hispanic, 2.5% Asian, 2.5% Middle Eastern and 0% African American. The school has low ethnic diversity, with mainly Caucasian students making up 96.7% of the campus (McCall, 2004). The school is located in a suburban/rural area of the Midwest region of the United States that has a population under 10,000. The town where the school is located has a demographic makeup of 89% Caucasian, 4.7% Hispanic, 2.6% Multi-Racial, 1.3 % Asian, 1.1% American Indian, and 1% African American. The religious demographics, based on residents who identify as adherents of a particular religious affiliation, are 60% Catholic, 23 % other, 12% Lutheran and 5% Methodist.

3.1 Procedures

The study administered three questionnaires/surveys given pre-evolution instruction, which tested the following among students: understanding of the nature of science, understanding of evolutionary theory and acceptance of the evolutionary theory. Following the pre-assessments, a four week instructional unit on evolution was taught. At the conclusion of the instructional unit, the same questionnaires were given as post-assessments. The pre-assessments were given to determine what each student

believed and/or understood before being taught evolution and the post-assessments were given to analyze any changes in beliefs and/or understanding after the evolution unit.

The data collected consisted of information on the extent to which students (male and female) understood evolutionary theory, viewed the nature of science, connected religious explanations to evolution, and accepted evolution. The existing data was analyzed according to the research questions, specifically focusing on possible gender differences in understanding and beliefs on the topics of evolution and the nature of science. Also examined was the possible influence of religion on the acceptance of evolution. This study was based on the work of previous research (Cavallo & McCall, 2008; McCall, 2004). Religiously phrased questions and answers were chosen from the pre-assessments used in the study (McCall, 2004). All instruments used in this study are included in Appendix A.

3.2 Instruments

3.2.1. Science Knowledge Questionnaire

This questionnaire measured student beliefs about nature of science (NOS) as adapted from Ryan and Aikenhead (1992). The format of the questions were a 4 point Likert Scale, where A = Strongly Disagree, B = Generally Disagree, C = Generally Agree and D = Strongly Agree. Responses were assigned a numeric value for analysis purposes; A=1, B=2, C=3 and D=4. Views of nature of science, as used in this study, were conceptualized as tentative, evidence-based, and dynamic, or as fixed, authoritatively known and unchanging. Questions 29-33, 36, 37 and 41 represented tentative views and questions 27, 28, 34, 35, 38-40 and 42 represented fixed views. For

questions representing the fixed view, the scale was inverted; therefore, 1=4, 2=3, 3=2, and 4=1. This means that students with lower scores held fixed views of nature of science, while students with higher scores held tentative views of nature of science. Prior to the study, the validity of these questions were determined via peer review, which included the expertise of one university professor of science education and three biology teachers from the campus being surveyed. The instrument has also been used in previous research (Cavallo & McCall, 2008; Cavallo, White & McCall, 2011; McCall, 2004).

3.2.2. Understanding Evolution Test (UE)

The test measuring student understanding of evolution (UE) was adapted from a test created by Settlage and Jensen, Understanding Biological Change (UBC) version B (1996). A two-tiered format was utilized in this test, not only to identify what answer the student chose, but also their reasoning for choosing that answer. The test consisted of twelve two part questions, where part of the answer was a number and part was a letter. Then the remaining eight questions only have letters as the answer choices; however, these questions were split into response and explanation parts, in which the explanations follow the responses. Students' scores ranged from 0 to 20, where higher scores indicated greater understanding of evolution. The reliability of this survey was previously determined to be a .868 (Settlage & Jensen, 1996).

3.2.3. Acceptance of Evolution Measure (AE)

The instrument used to measure student acceptance of evolution (AE) was adapted from another testing instrument called the Measure of Acceptance of the

Theory of Evolution or MATE (Rutledge & Warden, 1999). Questions 17 and 25 were added via peer review to test students' overall perception of the theory of evolution. The AE questionnaire covered a variety of topics, such as the age of the Earth, human evolution, using evolution to explain phenomena and evolutionary processes. It was based on a five point Likert scale, where A = Strongly Agree, B = Agree, C = Undecided, D = Disagree and E = Strongly Disagree. There were negatively and positively phrased questions in this survey. Questions 6, 8, 10, 11, 13, 14, 17, 18, 19, 21 and 23 were negatively phrased and questions 5, 7, 9, 12, 15, 16, 20, 22 and 24-26 were positively phrased. Scores closer to 1 indicated a lower acceptance of evolution, while scores closer to 5 indicated a higher acceptance of evolution. Each question was scored in this manner; therefore, student scores could range from 22 to 110. The validity of this survey was determined in the earlier study using a panel of experts who reviewed the items (McCall, 2004). The reliability of the original source, the MATE, was found to be .92 for test-retest reliability statistical analysis, and .94 for the internal consistency reliability (Rutledge & Sadler, 2007).

3.2.4. Religious Beliefs (RB) as Associated with Evolution

Two survey items were used as indicators of the extent to which students tied evolution to religion, or religiosity of the students. The religiosity items were selected by a professor and undergraduate student of education and science, and were previously approved in the initial study via peer review (McCall, 2004). The first question, 14, was embedded within the survey testing understanding of evolution, while the second question, 18, was within the survey testing acceptance of evolution. Both questions

directly questioned students as to whether they believe the religious explanation of life on earth, which provided indication, through their answer choice, if they identify themselves as religious. Based on the students' response to these two questions, and their responses to the other surveys, it was possible to determine if religious beliefs influenced the students' views and acceptance of evolution. Question 14 provided two answer choices, A and D, which indicated religiosity and the other two choices, B and C, did not; therefore, if a student chose A or D, they received a zero and if they chose B or C they received a one. Question 18 provided answer choices that stated the degree to which a student agreed or disagreed with a given statement through letters A through E (A = strongly agree to E = strongly disagree). The students' response to this question was then converted to a number scale (1 = strongly agree, to 5 = strongly disagree). The scores for both questions were then combined for each student, in order to achieve a single score for religiosity, or RB. Low scores indicated high religiosity and high scores indicated low religiosity. Scores could range from 1 to 6.

3.3 Instruction on Evolution

The instructional unit was created using the textbook, *Biology- The Study of Life* by Schraer and Stoltze, Seventh Edition, copyright 1999, published by Prentice Hall, Upper Saddle River, New Jersey. An overview of the concepts discussed and/or taught were: Charles Darwin, evolutionary processes and natural selection. Other resources were consulted as well, such as the website series, *Evolution,* produced by PBS, station WGBH, 2001 (http://www.pbs.org/wgbh/evolution/, retrieved 10-10-03). Videos from this series were often used as supplemental material. The instructional unit combined

inquiry based learning and lecture/discussion to teach the concepts of evolutionary theory. The instruction took place over a period of four weeks.

All data from the instruments used in this study was entered on a spreadsheet. Statistical analysis was conducted using the data from the pre- and post-assessments in SPSS.

CHAPTER 4

RESULTS

4.1 Research Question 1

Descriptive patterns and differential shifts from pre- to post-evolution instruction (time) between male and female students' views of nature of science (NOS), understanding of evolution (UE), religious beliefs (RB), and acceptance of evolution (AE) and the interactions between pre- and post-scores (time) and gender.

Descriptive statistics were computed in response to the first research question of this study for the whole group and according to gender. The descriptive statistics are shown in Table 4.1. To observe patterns in these findings, the descriptive data for each variable is graphically presented in Figures 4.1 through 4.4.

Repeated measures analyses were next conducted to determine if the observed descriptive data in Table 4.1 and Figures 4.1 through 4.4 represented significant shifts in each tested variable (nature of science- NOS, understanding evolution- UE, religious beliefs- RB, and acceptance of evolution- AE) from pre- to post-test (time), by gender, and the interaction between time x gender. These data are shown in Tables 4.2 through 4.5.

Table 4.1 Data Table of Means and Standard Deviations for Each Assessment by Group Total and Gender

Assessment	Group Total		Males		Females	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Nature of Science (NOS)						
Pre	42.88	5.57	42.51	6.65	43.19	4.50
Post	43.16	3.86	43.59	4.29	42.74	3.42
Understanding of Evolution (UE)						
Pre	5.71	3.04	5.35	2.86	6.02	3.20
Post	9.37	4.10	9.46	4.33	9.30	3.94
Religious Beliefs (RB)						
Pre	3.05	1.54	2.97	1.65	3.12	1.45
Post	3.27	1.62	3.31	1.73	3.23	1.55
Acceptance of Evolution (AE)						
Pre	64.31	5.81	64.41	6.71	64.23	5.0
Post	65.82	14.23	66.03	13.63	65.62	14.96

A graphic representation of the descriptive data for the pre- and post-test questionnaire on students' views of the nature of science (NOS) is shown in Figure 4.1.

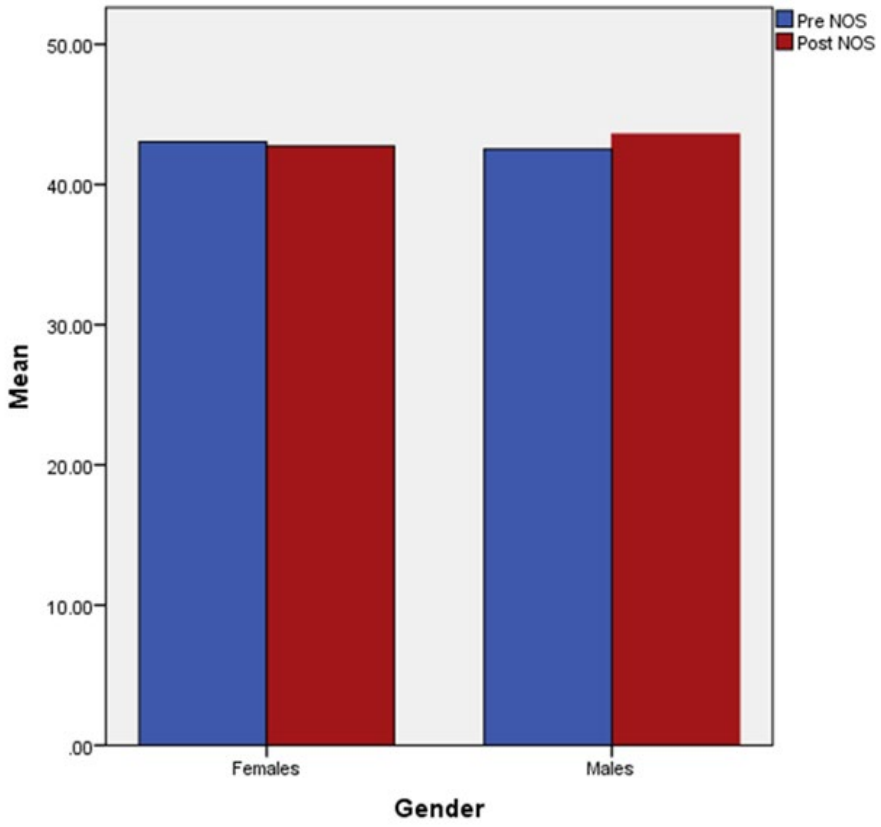

Figure 4.1 Pre- and Post-Assessment Means on Nature of Science (NOS) by Gender

Based on the data represented in Figure 4.1, the difference between pre- and post-NOS assessments is descriptively minimal for both genders. The bars do not change a great amount from pre- to post-assessment; they are nearly the same mean values between the two testing times. There is also no relative difference between females and males; the mean for the females is almost the same as the mean for the males, as observed in Table 4.1. Figure 4.1 shows that there is no gender difference for NOS before and after instruction.

Levene's Test of homogeneity was conducted on NOS and determined as not significant (p >.05); therefore, homogeneity of variance was not violated. A repeated measures analysis was conducted on the NOS assessment on time, gender, and time x gender as shown in Table 4.2.

Table 4.2 Repeated Measures Analysis on Nature of Science (NOS) on Time, Gender, and Time X Gender

Source	df	Mean square	F	Significance
Time	1	5.68	.29	.60
Gender	1	.93	.04	.85
Time*Gender	1	18.31	.95	.33

As indicated in Table 4.2 there was no level of significance (p >.05) for NOS by time, gender, or interactions between time and gender.

Figure 4.2 graphically represents the descriptive data for students' understanding of evolution (UE) according to gender on the pre- and post-instruction assessment.

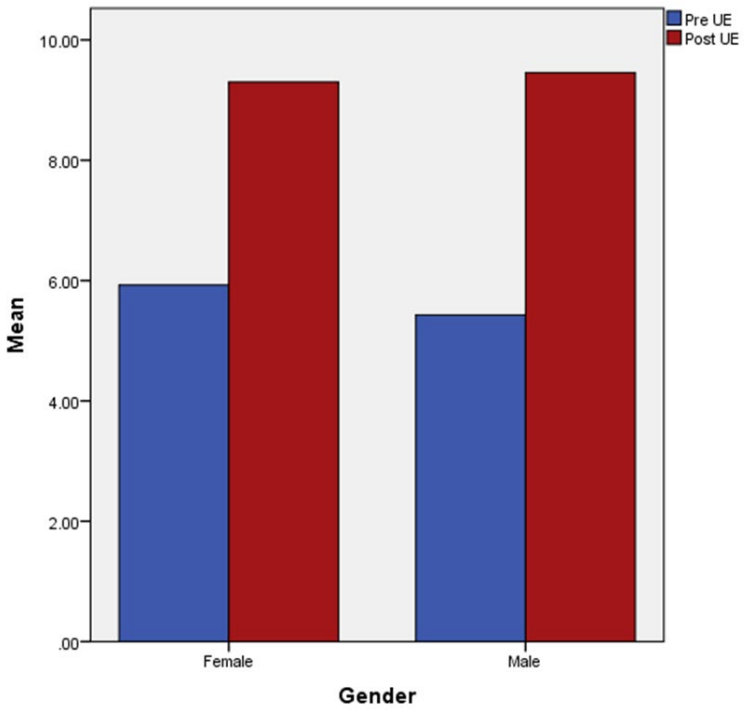

Figure 4.2 Pre- and Post-Assessment Means on Understanding of Evolution (UE) by Gender

As indicated in Figure 4.2, the pre- and post-instruction scores for UE produced similar results between males and females; therefore, the descriptive pattern does not appear to show differences in mean scores according to gender. The post-UE assessment means for females and males were almost equal, as represented in Table 4.1. However from a descriptive analysis, the pre-UE assessment mean was slightly lower in males than in females, as indicated in Table 4.1.

Levene's Test of homogeneity was conducted and determined as not significant (p >.05); therefore, homogeneity of variance was not violated. As represented in Table

4.3, the repeated measures analysis test was completed on UE for time, gender, and time x gender.

Table 4.3 Repeated Measures Analysis on Understanding of Evolution (UE) on Time, Gender, and Time X Gender

Source	df	Mean square	F	Significance
Time	1	511.59	53.72	.001
Gender	1	1.07	.06	.80
Time*Gender	1	3.98	.42	.52

As shown in Table 4.3, the change in scores over time (pre to post) for all students in the study was significant (p <.05); however, there was no difference between males and females and no interaction of time x gender. These findings indicate that all students' understanding of evolution significantly increased from pre- to post-test, and the shift was not different for males or females in the study.

A graphic representation of the descriptive data for students' religious beliefs (RB) according to gender on the pre- and post-instruction assessment is shown in Figure 4.3.

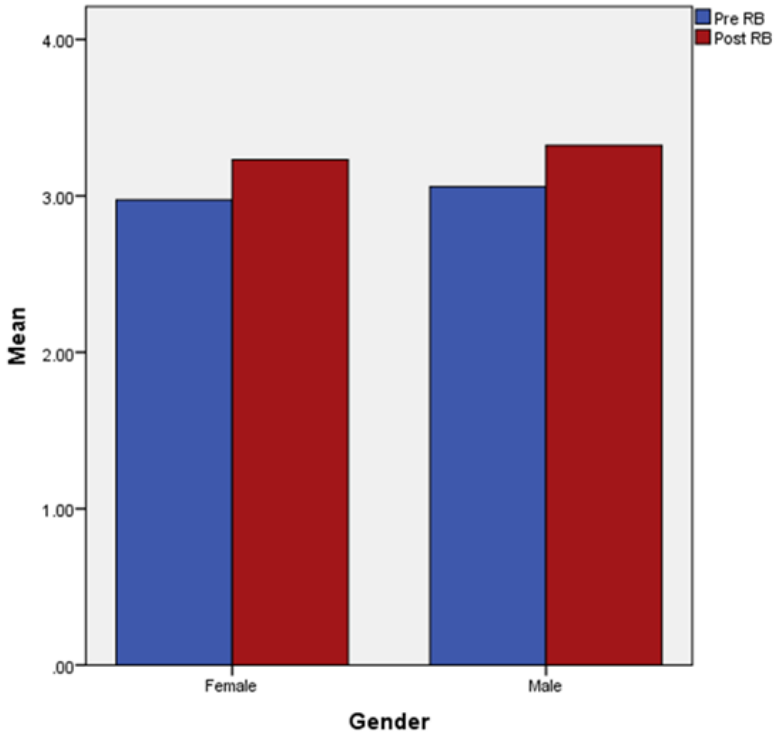

Figure 4.3 Pre- and Post-Assessment Means on Religious Beliefs (RB) by Gender

As indicated in Figure 4.3, the RB of males and females are similar pre- and post-RB assessment. Descriptively, the pre-instruction means of females and males on RB scores were slightly different with females numerically lower than males (indicating higher RB). The post-instruction means of females and males are very similar, as shown in Table 4.1. Both males and females experienced a numerical increase in RB from pre- to post-instruction. The data indicates that males and females tied the theory of evolution to religion more in the pre-instruction assessment that they did in the post-

instruction. This finding is interpreted from the scoring method used on the religious beliefs (RB) assessment, in which higher scores indicated students did not tend to connect evolution to RB, whereas low scores indicated students did connect evolution to RB.

Levene's Test of homogeneity of variance was conducted and determined as not significant (p >.05); therefore, homogeneity of variance was not violated. As shown in Table 4.4, a repeated measures analysis test was conducted on the RB assessment for time, gender, and time x gender.

Table 4.4 Repeated Measures Analysis on Religious Beliefs (RB) on Time, Gender, and Time X Gender

Source	df	Mean square	F	Significance
Time	1	2.47	3.07	.08
Gender	1	.29	.07	.80
Time*Gender	1	.001	.001	.98

As indicated in Table 4.4, there was no level of significance (p >.05) on RB for time, gender, or interactions between time and gender. Though not significant, it is noted that differences for the whole group from pre- to post-instruction on their acceptance of evolution (AE) approached significance (p = .08).

Figure 4.4 graphically represents the descriptive data for students' acceptance of evolution (AE) according to gender on the pre- and post-instruction assessment.

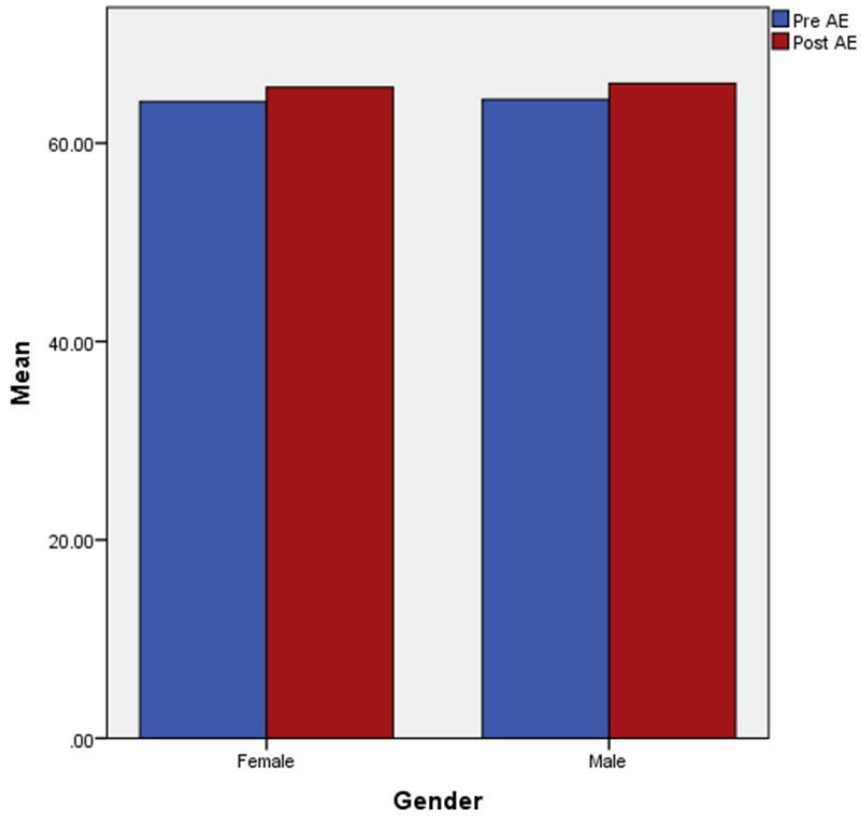

Figure 4.4 Pre- and Post-Assessment Means on Acceptance of Evolution (AE) by Gender

As represented in Figure 4.4, there were similar outcomes in the pre- and post-AE assessment among males and females. The means for males and females on AE were similar on the pre- and post- instruction assessments, as indicated in Table 1.1. There is only a slight increase in their AE after instruction for both genders, as observed in Figure 4.4.

Levene's Test of homogeneity was conducted and determined as not significant (p >.05); therefore, homogeneity of variance was not violated. As shown in Table 4.5,

the subsequent test conducted was a repeated measures analysis on the AE assessment for time, gender, and time x gender.

Table 4.5 Repeated Measures Analysis on Acceptance of Evolution (AE) on Time, Gender, and Time X Gender

Source	df	Mean square	F	Significance
Time	1	88.75	.76	.39
Gender	1	3.86	.03	.86
Time*Gender	1	.33	.003	.96

As indicated in Table 4.5, there was no level of significance (p >.05) for scores on AE for time, gender, or interactions between time and gender.

4.2 Research Question 2

Interrelationships among male and female students' views of the nature of science (NOS), understanding of evolution (UE), religious beliefs (RB), and acceptance of evolution (AE) pre- and post- evolution instruction

To answer research question two, the data collected from the assessments (NOS, UE, RB and AE) was analyzed among males and females for both the pre-instruction and post-instruction assessments. Correlation analyses were conducted to determine possible interrelationships between the variables of this study for males and females both before instruction (pre-test) and after instruction (post-test). Table 4.6 shows the pre-test correlation analyses on interrelationships between NOS, UE, RB, and AE for females. Table 4.7 shows the pre-test correlation analyses on interrelationships between NOS, UE, RB, and AE for males.

Table 4.6 Correlation Analyses between the Pre-Test Scores of This Study for Females

	Pre-Understanding of Evolution (UE)	Pre- Nature of Science (NOS)	Pre- Religious Beliefs (RB)	Pre-Acceptance of Evolution (AE)
Pre UE				
Correlation	1	.17	.005	.17
Significance		.30	.98	.30
Pre NOS				
Correlation		1	-.05	.09
Significance			.75	.58
Pre RB				
Correlation			1	-.23
Significance				.13
Pre AE				
Correlation				1
Significance				

There were no inter-correlations among the pre-tests for females, as can be observed in Table 4.6. None of the tests were significantly correlated ($p > .05$).

Table 4.7 Correlation Analyses between the Pre-Test Scores of this Study for Males

	Pre-Understanding of Evolution (UE)	Pre- Nature of Science (NOS)	Pre- Religious Beliefs (RB)	Pre-Acceptance of Evolution (AE)
Pre UE				
Correlation	1	.21	-.04	.15
Significance		.20	.82	.38
Pre NOS				
Correlation		1	-.15	.41*
Significance			.39	.01
Pre RB				
Correlation			1	-.36*
Significance				.03
Pre AE				
Correlation				1
Significance				

*Correlation is significant at the .05 level (2-tailed)

As indicated in Table 4.7, there is a positive and significant (p <.05) correlation between NOS and AE for males. However, there is a significant negative correlation between RB and AE for males. This indicates that low religious beliefs are associated with lower acceptance of evolution, and higher religious beliefs are associated with higher acceptance of evolution.

The assessments (NOS, UE, RB and AE) were analyzed for significant correlations for the post-tests among the males and females. Table 4.8 shows the correlation matrix on the post-tests for females and Table 4.9 shows the correlation matrix on the post-tests for males.

Table 4.8 Correlation Analyses between the Post-Test Scores of this Study for Females

	Post-Understanding of Evolution (UE)	Post- Nature of Science (NOS)	Post- Religious Beliefs (RB)	Post-Acceptance of Evolution (AE)
Post UE				
Correlation	1	-.01	.13	.14
Significance		.94	.44	.39
Post NOS				
Correlation		1	.22	.22
Significance			.18	.17
Post RB				
Correlation			1	.85**
Significance				.00
Post AE				
Correlation				1
Significance				

**Correlation is significant at the 0.01 level (2-tailed)

As shown in Table 4.8, RB and AE were significantly positively correlated ($p <$ .01). This correlation indicates that higher religious beliefs are associated with lower acceptance of evolution, and lower religious beliefs are associated with higher acceptance of evolution among the females. All other post-tests were not significantly correlated for the female students in this study.

Table 4.9 Correlation Analyses between the Post-Test Scores of this Study for Males

	Post-Understanding of Evolution (UE)	Post- Nature of Science (NOS)	Post- Religious Beliefs (RB)	Post-Acceptance of Evolution (AE)
Post UE				
Correlation	1	.19	-.004	.10
Significance		.28	.98	.57
Post NOS				
Correlation		1	.22	.22
Significance			.21	.19
Post RB				
Correlation			1	.75**
Significance				.00
Post AE				
Correlation				1
Significance				

**Correlation is significant at the 0.01 level (2-tailed)

As shown in Table 4.9, RB and AE were significantly positively correlated ($p <$ .01). Similar to the females in this study, this correlation indicates that higher religious beliefs are associated with lower acceptance of evolution, and lower religious beliefs are associated with higher acceptance of evolution among the males. Also similar to the female students, all other post-tests were not significantly correlated for the male students in this study.

4.3 Research Question 3

Predictive influence of male and female students' views of the nature of science (NOS), understanding of evolution (UE), and religious beliefs (RB) on their pre- and post-instruction acceptance of evolution (AE)

These analyses examined the possible extent to which the pre- and post-instruction assessments (NOS, UE and RB) predicted male and female students' acceptance of evolution (AE). The students' scores on NOS, RB, and UE assessments were entered in stepwise regression analyses as predictor variables, with acceptance of evolution as the dependent variable. These results are shown in in Table 4.10. The stepwise regression analyses were conducted separately for the pre- and post-tests to observe any similarities and/or differences in predictors of AE before and after students experienced the instructional unit on evolution. The analysis was also completed by gender, to explore similar and/or unique predictors among NOS, UE, and RB for females and males on their acceptance of evolution (AE).

Table 4.10 Stepwise Regression Analyses on Pre- and Post-Assessment Predictors (NOS, UE, RB) on Acceptance of Evolution (AE) for Males and Females

	Males		Females	
	Pre Test	Post Test	Pre Test	Post Test
Predictor of AE	NOS	RB	-	RB
R Square	.18	.56	-	.72
ANOVA				
F	7.58	42.16	-	93.67
Significance	.009	.001	-	.001

The results of the stepwise regression showed that prior to instruction, pre-test NOS, UB and RB did not significantly predict pre-instruction acceptance of evolution (AE) for females. However, for the females, after evolution instruction, post-test RB was a significant predictor of post-test AE, as shown in Table 4.10. Among females, RB explained 72% of the variance in acceptance of evolution (AE).

The stepwise regression analyses results for males on pre-instruction tests indicated that pre-test NOS significantly predicted pre-test acceptance of evolution, before they experienced the instruction unit. Pre-NOS scores explained 18% of the variance in pre-AE among males. The results of the stepwise regression on post-instruction tests for the males were similar to those found among the females; post-test RB significantly predicted post-test acceptance of evolution after the instructional unit on evolution (see Table 4.10). For the males RB explained 56% of the variance in acceptance of evolution (AE) scores after instruction on evolutionary theory.

CHAPTER 5

DISCUSSION

5.1 Interpretation of Results

5.1.1 Research Question 1

The first research question of this study explored patterns and differential shifts from pre- to post-test (time) between males and females on nature of science (NOS), understanding evolution (UE), religious beliefs (RB) and acceptance of evolution (AE), as well as possible interactions between time and gender. Based on the results, it is evident that males and females had similar mean scores in all variables tested, and were not significantly different. This indicates that females and males are essentially equal particularly in their views of nature of science, understanding of evolution and acceptance of evolution. In examining shifts in understanding of evolution (UE), both males and females significantly increased from pre- to post-instruction. Thus, males and females were successful in learning evolution experienced in the instructional unit. Students achieving greater understanding of evolution may be connected to the descriptive, trend level shift in students' connecting evolution to religion (RB) from pre-test to post-test for the whole group ($p = .08$). This trend level would require further research to explore its salience; however, it may be described from a descriptive perspective. The descriptive-level shift in religious beliefs would imply that before instruction, students tended to connect their explanations for evolution to religion, and

this tendency decreased among the students after evolution instruction. In examining the means in religious beliefs at a descriptive level, males seemed to tie religion to acceptance of evolution slightly less than females. Students' potential decrease in tying evolution to religious beliefs, after experiencing instruction on evolution, should be explored in future research.

5.1.1.1 Research Question 1- Null Hypotheses

The first null hypothesis predicted that there would be no significant shifts from pre- to post-evolution instruction in nature of science (NOS), understanding evolution (UE), religious beliefs (RB) and acceptance of evolution (AE) for the group. The group increased in their understanding of evolution from pre- to post-instruction. Therefore to respond to the first part of research question 1, the null hypothesis is rejected for UE, but is not rejected for NOS, RB, and AE, which showed no significant shifts from pre- to post-instruction.

The second null hypothesis predicted that there would be no significant differences between males and females in NOS, UE, RB and AE pre- to post-evolution instruction. Since males and females were similar in their scores for each assessment, both pre- and post-instruction, no significant differences were found. The results on this part of research question 1 fails to reject the null hypothesis.

The third null hypothesis predicted that there would be no significant interactions between pre- and post-evolution instruction (time) and gender for NOS, UE, RB and AE. Since both genders had similar changes among the test variables, from

pre- to post-instruction, this study fails to reject the null hypothesis for the third part of research question 1.

5.1.2 Research Question 2

The second question of this research investigated interrelationships between NOS, UE, RB, and AE on the pre-test and post-test for males and females. The correlation analyses revealed that none of the pre-tests were significantly inter-correlated for females; however, nature of science and acceptance of evolution were positively correlated for males. Before learning evolution in the instructional unit, males with more tentative, evidence-based views of nature of science were more likely to accept evolution, and males with more fixed and authoritatively known views of nature of science were less likely to accept evolution. These results support other research conducted on the relationship between a student's view of nature of science and their acceptance of evolution (Abd-El-Khalick & Lederman, 2000; Cavallo & McCall, 2008). The pre-instruction correlation analyses among the males also revealed a significant negative correlation between tying evolution to religion (RB) and their acceptance of evolution. In this study, the tendency not to tie religion to evolution received a higher score, whereas tying religion to evolution received a lower score. Thus, the negative correlation of religious beliefs among the males before instruction is contrary to what would be expected: those who tied religion to evolution less were also less likely to accept evolution. Perhaps males had an inadequate or incomplete understanding of evolution prior to instruction, or it could have been found by chance. These or other relationships among variables were not shown among the females on the pre-tests.

Essentially there were no associations between any of the variables tested among females on the pre-tests, thus they were independent or not connected among this group.

The post-instruction correlation analyses revealed religious beliefs as significantly and positively correlated to acceptance of evolution for both males and females. Thus, the more students tied religion to evolution, the less likely they were to accept evolutionary theory; and the less they tied the theory to religion, the more likely they were to accept evolution. This finding was revealed for both males and females in this study. The finding also indicates a reversal from what was found among the males on the pre-instruction tests, where there was a negative association between tying religion to evolution and acceptance of the theory. For both male and female students, the correlation between post-RB and post-AE was positive; thus, higher religious beliefs indicated students connected religion to evolution, and resulted in a lower acceptance of evolution; whereas lower religious beliefs indicated students did not tend to tie religious explanations to evolution, and resulted in a higher acceptance of evolution. This relationship is consistent with what would be expected, as it is commonly found that individuals who are more strongly tied to their religious beliefs are less likely to accept evolution. It is speculated that the difference in correlational findings observed on the post-tests compared to the pre-tests may be due to students not realizing the disassociations between religious beliefs and acceptance of evolution prior to learning about evolution in the instructional unit. Perhaps after the unit, in which students gained more understanding about evolution (as indicated by higher understanding of evolution scores), they held more tightly to their religious beliefs and did not give credence to

what they had learned in the instructional unit on evolution – even if they understood the theory.

5.1.3 Research Question 3

The third research question explored possible predictive influences of NOS, UE, and RB on students' acceptance of evolution (AE) among males and females pre- and post-instruction. For females, as could be expected from the non-significant pre-test correlations, none of the variables significantly predicted acceptance of evolution before instruction. Prior to instruction for females, their views of nature of science, understanding of evolution, or religious beliefs did not explain whether or not they accepted evolutionary theory. This finding is contrary to studies that conclude that females are considered more active in their religion than males (Simpson, 2008). Further, females' religious beliefs could be presumed to predict acceptance of evolution in the pre-test according to sources that indicate religion influences students' acceptance of evolution and overall educational attainment (Darnell & Sherkat, 1997; de Souza, de Carvalho, Matsuo & Zaia, 2010).The prior research is applicable because the evolution unit had not been taught yet; therefore, the few factors influencing the students' acceptance would have been prior knowledge, religious beliefs and possibly misconceptions about the topic. It would be plausible that nature of science could have predicted acceptance of evolution in the pre-test for females as well as religious beliefs, because students' views of nature of science have been found to influence their perception and acceptance of evolution (Cavallo & McCall, 2008). However, the conclusions of these sources are not supported by the results among the females in this

study. In contrast, the pre-NOS assessment did predict the pre-AE assessment for males. Thus, males who had more tentative views of nature of science were more likely to accept evolution, whereas males with fixed views were less likely to accept evolution. This finding supports research that concludes similar results, in which nature of science influences acceptance of evolution (Cavallo & McCall, 2008). Another reason nature of science may have predicted pre-AE for males was due to males having better access to education and possibly being encouraged in STEM fields, which parallels other studies (Lauer et al., 2013; Norton & Tomal, 2009).

Due to pre-RB not predicting pre-AE for males or females, evidence of males being less involved in religion than females (Simpson, 2008) is not evident. Sources that connect religiosity to acceptance of evolution have posited that males, being reported as less religious, would relate the two topics less and separate the two (de Souza, de Carvalho, Matsuo & Zaia, 2010). At the beginning of the instructional unit, students did not have a strong understanding of evolutionary theory, thus making connections to religious explanations did not predict their acceptance of evolution.

After instruction, only religious beliefs significantly and positively predicted acceptance of evolution for both males and females in the study. Notably, the extent to which religious beliefs predicted acceptance of evolution was different for males and females. For females, religious beliefs predicted 72% of the variance in acceptance of evolution scores after evolution instruction. Thus their acceptance of evolution is, to a large extent, explained by whether or not they tie evolution to religion. For males, religious beliefs explained 56% of the variance in acceptance of evolution scores after

instruction. Thus, after learning evolution, males and females who did not tend to tie evolution to religious explanations had greater acceptance and those who did form or maintain these connections were more likely to reject evolution. That greater variance among females in religious beliefs as predicting acceptance of evolution, compared to males, may support research that indicates religious participation as being dominated by females and weaker in males (Simpson, 2008). While religious beliefs were the only predictor of acceptance of evolution in the post-assessment for both genders, this did not indicate an increase in religiosity. It simply resulted in a stronger pattern among both genders in connecting or disconnecting religious explanations to acceptance of evolution. The tendency to tie religion to evolution (RB) among both males and females actually decreased slightly from pre- to post-test, and the acceptance of evolution of both genders slightly increased from pre- to post-test, which was the trend-level finding associated with research question 1. In this study, religious beliefs, or the extent to which all students connected or failed to connect religion to evolutionary theory, predicted whether or not they accepted evolution, and more markedly so for the females. This increase in acceptance of evolution after learning and gaining experience with the theory through instruction is supported by previous research (Ingram & Nelson, 2006). Post-instruction, nature of science and understanding of evolution did not significantly predict males' or females' acceptance of evolution beyond that explained by religious beliefs. Thus, religious beliefs were a strong influence on acceptance of evolution, especially for females, regardless of their views of nature of

science as scientifically based, or the extent to which the students understood evolutionary theory after instruction.

5.1.3.1 Research Questions 2 & 3- Null Hypotheses

The null hypothesis for research question 2 predicted that there would be no significant interrelationships among the pre- and post-evolution instruction variables of nature of science (NOS), understanding evolution (UE), religious beliefs (RB) and acceptance of evolution (AE) for males and females. In the pre-test results for males, in which nature of science was correlated to acceptance of evolution, the null hypothesis was rejected for nature of science, but not rejected for all other variable correlations. In the pre-test results for females, in which no correlations occurred, the null hypothesis was not rejected. In the post-test results for the males and females, in which religious beliefs were correlated to acceptance of evolution in both genders, the null hypothesis was rejected for religious beliefs and acceptance of evolution, but not rejected for all other variable correlations.

The null hypothesis for research question three predicted that students' views of the nature of science (NOS), understanding of evolution (UE), religious beliefs (RB) and acceptance of evolution (AE) would not significantly predict AE pre- and post-instruction for males and females. In the pre-test results for the males, in which nature of science predicted acceptance of evolution, the null hypothesis was rejected for nature of science, but not rejected for all other test variables. In the pre-test results for the females, in which no test variables predicted acceptance of evolution, the null hypothesis was not rejected. In the post-test results for males and females, in which

religious beliefs predicted acceptance of evolution for both genders, the null hypothesis was rejected for religious beliefs, but not rejected for all other test variables.

5.2 Limitations of the Study and Future Research Recommendations

A limitation of the study was the sample size. Although 81 students were included in the study, the data may have been more conclusive with a greater number of students. While this study tested ninth grade students, it would be interesting to test tenth, eleventh, and twelfth graders as well. They could be taught the same unit and given the same pre- and post-assessments, but their results might vary according to age, maturity and/or prior exposure to evolution. Another limitation was the lack of diversity within the sample, because a majority of the students were Caucasian. This lack of diversity limits the generalizability of the study to other populations. The lack of diversity was due to the region of the US in which the students were located, the Midwest rural region of the United States. Most of the population in this area is Caucasian; therefore, the results collected only apply to that particular race. It would be interesting to create a similar study in an area that offers more diversity, such as large urban area. Urban schools would provide substantial diversity and enable variances among race to be tested, as well as gender. The region may have also influenced the responses to the questions involving religion, and as a result, the conclusions involving religiosity. Since that area of the US is predominately Christian and Roman Catholic, it can be inferred that many of students identified themselves as Christian or Roman Catholic. Using this study in other areas of the country, where there is more diversity in religious beliefs and affiliations could provide more comprehensive results. Moreover,

it would be worthwhile to investigate student groups with religious diversity and explore whether results are tied to specific religious affiliations. A future study would ask students to identify which religion they specifically belong to, and perhaps include more depth in measuring the extent of students' religiosity as influencing acceptance of evolution. Qualitative research, including interviews with students on possible connections between religiosity and acceptance of evolution, would also add insights to the current findings.

5.3 Implications of Research

The results of this study present several implications for educators teaching the theory of evolution, as well as evidence supporting teaching methods already in place and being practiced. For instance, the first research question concluded that males and females are similar in their understanding of nature of science and in understanding of evolution. This shows that educators do not have to teach males and females differently in order for both of them to comprehend the nature of science and understanding of evolution. The only change would be for educators to incorporate more inquiry style teaching, if they do not already, because the instructor of the evolution unit did so in the study. This was a positive influence on the students' learning, because both males and females increased in their understanding of evolution from pre-assessment to post-assessment. The descriptive level increase in religious beliefs and acceptance of evolution from pre-assessment to post-assessment occurred among males and females; however, it is unclear if the instructional unit is responsible for this shift in acceptance of the theory as these shifts were not statistically significant.

The second research question concluded that pre-NOS and pre-AE were correlated for male students. Since males connected what they knew about NOS pre-instruction to their acceptance of evolution, science educators need to be aware that promoting a more tentative view of nature of science may be related to how their male students perceive evolution, even if they do not teach evolution in the class. As a result, teaching nature of science as tentative allows male students to address the learning of evolution as consistent with nature of science, that is, the theory is based on evidence, as is all science, and tentative and changing with such new evidence. Evolutionary theory is one of the best examples of nature of science, and all students, both male and female, could benefit from better understanding the tentative, evidenced based nature of science. Teaching nature of science as fixed may create misunderstandings about nature of science as unchanging and authoritatively known, which may in turn be associated with the extent to which students accept or reject evolution. The negative correlation that occurred in the pre-assessment for males, between religious beliefs and acceptance of evolution, is a unique finding. Generally, the less religious someone is, the more they tend to believe in science and evolution; however, in the pre-assessment the lower religious beliefs resulted in a lower acceptance of evolution. This could indicate a lack of understanding of the theory pre-instruction, or it could be a finding that happened by chance. More research would be needed to substantiate this unexpected finding.

The post-assessments for the second and third research questions showed a positive correlation between religious beliefs and acceptance of evolution for both males and females, and religious beliefs significantly predicted acceptance of evolution.

This result would be expected, since the more religious the student, the less likely they may be to accept evolution, whereas the less religious the student, the more likely they may be to accept evolution. Based on these findings, educators can learn that after the instruction, students link their religious beliefs to their acceptance of evolution and vice versa. Students' are not likely to dismiss their religious beliefs because they learn evolutionary theory in school, and it is not within our purview as educators to address or influence such beliefs. This finding of religious beliefs predicting acceptance of evolution occurred among males and females; therefore, religious beliefs are consistent across gender. Males and females tied religion less to evolutionary theory after instruction; and those students were also more likely to accept evolution. Perhaps before gaining understanding of evolution, students associated evolution with religious beliefs due to public controversy that exists with this theory, or because religion may have been the only other source of information they had about how organisms came to exist. However, at the end of the instructional unit students may have gained deeper understandings of evolution such that they were able to separate the theory from religious explanations. They gained the scientific, evidenced-based theory for how organisms came to exist on earth. It is posed that by becoming more informed about evolution students were less likely to view changes in species over time (evolution) through religious explanations. Since students only changed the extent of connecting religion to evolution, there no evidence that they experienced changes in religious beliefs. The issue of whether to teach evolution, for fear of students losing their

religious identity, is not supported in this study and should not be a concern for educators or parents.

Evolution is an important unifying theory in biology, supported by strong evidence, with new support being found and scrutinized by scientists around the world on a nearly daily basis. Religious faith is separate from science and should not interfere with students' learning of evolution. This study supports this premise, in that students learned evolution regardless of religiosity.

APPENDIX A

QUESTIONNAIRES AND TESTS

Study of Life and Science Knowledge Questionnaire, Understanding Biological Change Test

Background Information Questionnaire

1. Age:

   A. 13
   B. 14
   C. 15
   D. 16

2. Gender (optional):

   A. Female
   B. Male

3. Ethnicity (optional):

   A. Hispanic, Chicano, or Latin American
   B. White (non-Hispanic)
   C. Asian or Pacific Island American
   D. African-American
   E. Middle-Eastern
   F. Other

4. How many semesters of Life Science have you taken prior to this quarter?

   A. 0
   B. 1-2
   C. 3-4
   D. 5-6
   E. 7 or more

Study of Life Questionnaire *(Acceptance of Evolution – AE)*

Strongly Agree (A)	Agree (B)	Undecided (C)	Disagree (D)	Strongly Disagree (E)

5. Organisms existing today are the result of evolutionary processes that have occurred over millions of years.

6. The theory of evolution is not capable of being scientifically tested.

7. Modern humans are the product of evolutionary processes, which have occurred over millions of years.

8. The theory of evolution is based on assumption and not valid scientific observations and testing.

9. Most scientists accept evolutionary theory to be a scientifically convincing theory.

10. The available data are ambiguous as to whether evolution actually occurs.

11. The age of the earth is less than 20,000 years.

12. There is a significant body of data, which supports evolutionary theory.

13. Organisms exist today in essentially the same form in which they always have.

14. Evolution is not a scientifically valid theory.

15. The age of the earth is 4 billion years.

16. Current evolutionary theory is the result of sound scientific research and methodology.

17. I believe that evolution is not the best explanation for the way the world and its organisms have come to exist in their current form.

18. The theory of evolution cannot be correct since it disagrees with Biblical accounts of creation.

19. Humans exist today in essentially the same form in which they always have.

Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
(A)	(B)	(C)	(D)	(E)

20. Evolutionary theory is supported by factual, historical, and laboratory data.

21. Much of the scientific community doubts if evolution occurs.

22. The theory of evolution brings meaning to the diverse characteristics and behaviors observed in living forms.

23. With few exceptions, organisms on earth came into existence at about the same time.

24. Evolution is a scientifically valid theory.

25. I feel that evolution is the best explanation for how the world and organisms of today have come to exist in their current form.

26. Evolutionary theory generates testable predictions with respect to the characteristics of life.

Science Knowledge Questionnaire *(Nature of Science – NOS)*

Strongly Disagree (A)	Generally Disagree (B)	Generally Agree (C)	Strongly Agree (D)

27. Scientific knowledge is unchanging.

28. Scientific theories are discovered, not created by people.

29. Today's scientific laws, theories, and concepts may have to be changed in the face of new evidence.

30. A piece of scientific knowledge will be accepted if the evidence can be obtained by other investigators working under similar conditions.

31. Scientists' observations are affected by the ideas they have about their subject.

32. Science is always subject to adjustment in the light of solid, new observations.

33. Scientific knowledge expresses the creativity of scientists

34. The truth of scientific knowledge is beyond doubt.

35. Because of the validity of the scientific method, knowledge obtained by its application is determined more by the nature of science itself than the choices that scientists make.

36. Scientific knowledge is subject to review and change.

37. Scientific questions, methods, and results vary according to historical, cultural, and social settings.

38. Scientific truths are discovered by a few experts.

39. A scientific law is an exact report of the truth about our universe.

40. Scientific knowledge is constructed from discovered facts.

41. Disagreements among scientists can occur when they interpret facts differently (or interpret the significance of the facts differently). This happens because of different scientific theories.

Strongly	Generally	Generally	Strongly

Disagree	Disagree	Agree	Agree
(A)	(B)	(C)	(D)

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42. When scientists disagree on an issue (for example, whether or not low-level radiation is harmful), they disagree mostly because they do not have all of the

Understanding Biological Change *(Understanding Evolution – UE)*

DIRECTIONS: Each question on this test contains two parts. Your response to the first part involves selecting the option that best completes the phrase. These options are indicated with a 1 or a 2. The second part asks you to select the reason for the choice you made in the first part. After the word "BECAUSE"; you will find three choices marked with A, B or C. Choose the reason that best matches your understanding. Your response to each item will consist of a two-part answer. Answer each question in the corresponding blank on the answer sheet. Next to each item, you are to write the number and letter that best matches your understanding of biological change.

EXAMPLE
1)The energy in almost every food chain can be traced back to:
1. the Sun
2. insects
BECAUSE:
A. more animals belong to this group than to any other.
B. plants absorb their energy from the soil.
C. photosynthesis is the first step in most food chains.
Explanation: The Sun is the correct answer for the first part. Even though reason A is a true statement, it is not the reason that best matches the first half of the question. Reason B seems to match with the Sun, except that soil provides minerals for plants, not energy. *Therefore, the complete correct response is 1C.*

Sharks
1) Modern-day sharks can swim at speeds up to 30 knots. Suppose their ancestors swam at a much slower speed. The ability to swim fast probably:
1. developed for all the sharks in a few generations,
2. involved an increase in the percentage of sharks that can swim faster,
BECAUSE:
A. there was first a random genetic change in a few individuals.
B. the more the sharks used their muscles, the faster they became.
C. the need to catch prey caused them to swim faster.

Birds
2) Birds with long legs can feed in watery regions much better than can birds without long legs. If a large population of birds without long legs were transported to a remote island covered with very little dry land and lots of marshes, swamps, and ponds:
1. some birds would live and some would die,
2. the birds would gradually develop long legs,
BECAUSE:
A. all of the birds' legs would slowly change so they would be better for feeding.
B. the few birds starting out with longer legs would survive to reproduce.
C. the legs of every bird would change in the same way since they are all related.

Raccoons
3) A population of raccoons exists in an area that has had several years of very cold winters. If the winters continue to be severe in the future, we would expect that:
1. most of the raccoons will be able to live through the winter,
2. many of the raccoons will live but some will freeze to death,
BECAUSE:
A. some individuals, by chance, have thicker fur than others.
B. the raccoons will adapt to the cold weather.
C. the need to survive the cold will cause the raccoons to develop thicker fur.

Seals
4) Seals that live in Alaska have a fat layer. Their ancestors may not have had fat as thick as it is today. Over the centuries, changes in the seals have occurred since:
1. the need to keep warm caused the fat of every seal to get thicker,
2. more seals each generation have had thicker fat,
BECAUSE:
A. the seals wanted to adapt to their surroundings.
B. the offspring inherited a thicker layer of fat from their parents.
C. the few individuals that had a thicker fat layer lived to produce offspring.

Locusts
5) Many years ago, the spread of locusts was controlled with the chemical DDT. Recently, chemists have found that locusts do not seem to be harmed as much by DDT. The reason for this change is that:
1. a greater number of locusts each generation are unaffected by DDT,
2. over the years, all of the locusts gradually became less affected by DDT,
BECAUSE:
A. every generation, the individual locusts who survived DDT had offspring.
B. the need to survive caused the locusts to change.
C. the use of DDT led to a mutation of the DNA in the locusts.

Moths
6) A population of moths contains individuals that have either light or dark colored bodies. The forest where the moths live used to have trees with both light and dark trunks. Recently, a disease has wiped out all of the types of trees except those with the darkest trunks. The effect on the moths would be that every generation:
1. the light colored moths would develop slightly darker bodies,
2. there would be a greater proportion of dark moths in the population,
BECAUSE:
A. the moths would adapt to the change in the environment.
B. the need to survive would cause the moths to shift their color.
C. only those moths with dark bodies would escape predators and live to reproduce.

Bullfrogs
7) Bullfrogs can jump over 10 feet in a single hop. Suppose that the bullfrogs alive today had ancestors that could not jump as far. The ability to hop large distances probably:
1. developed for all the bullfrogs in a few generations,
2. involved an increase in the percentage of bullfrogs that could hop far,
BECAUSE:
A. the more that bullfrogs used their muscles, the further they could jump.
B. there was first a random genetic change in a few individuals.
C. the need to avoid predators caused them to jump further.

Butterflies
8) Butterflies with a long proboscis (feeding tube) can reach the nectar at the base of flowers better than can butterflies with shorter proboscis. Some flowers have shallow tubes with nectar at the bottom while other flowers have much deeper and narrower tubes. If a large population of butterflies with short proboscises were transported to a desert oasis covered entirely with plants whose flowers had very long tubes:
1. some butterflies would live and some would die,
2. the butterflies would gradually develop longer proboscises,
BECAUSE:
A. the few butterflies starting out with longer proboscises would survive to reproduce.
B. the proboscis of every butterfly would change in the same way since they are all related.
C. all of the butterflies' proboscises would slowly change so they would be better for reaching the nectar.

Evergreens
9) A population of evergreens exists in an area that has had several years of very hot and dry summers. If the summers continue to be severe in the future, we would expect that:
1. many of the evergreens will live but some will die because of the dryness,
2. most of the evergreens will be able to live through the summer,
BECAUSE:
A. the need to survive the summers will cause the evergreens to develop better ways to avoid drying out.
B. some individual evergreens have, by chance, better ways of conserving water.
C. the plants will adapt to the hot and dry weather.

Bats
10) Bats that feed at night have a very sophisticated sense of hearing. Their ancestors may not have heard as well as bats of today. Over the centuries, changes in the bats have occurred since:
1. the need to feed at night caused the hearing sense of every bat to increase,
2. more bats each generation have had better hearing,
BECAUSE:
A. the bats wanted to adapt to their surroundings.
B. the offspring inherited better hearing from their parents.
C. the few individuals that had better hearing lived to produce offspring.

Tuberculosis (TB) bacteria
11) Many years ago, bacteria that caused TB were controlled with a combination of three antibiotics. Recently, doctors have found that TB bacteria do not seem to be harmed as much by the three antibiotics. The reason for this change is that:
1. over the years, all of the bacteria gradually became less affected by penicillin,
2. a greater proportion of bacteria are unaffected by the penicillin each generation,
BECAUSE:
A. the need to survive caused the bacteria to change.
B. the use of antibiotics led to a mutation of the DNA in the bacteria.
C. every generation, the individual bacteria that survived the antibiotics reproduced.

Lizards
12) A population of lizards contains individuals that have either solid green or green-striped bodies. The region where the lizards live used to have grass plants with both solid green and green-striped leaves. Recently, a disease has wiped out all of the types of grass except those with the solid green leaves. The effect on the lizards would be that every generation:
1. the green-striped lizards would develop slightly less striped bodies,
2. there would be a greater proportion of individuals with solid green bodies,
BECAUSE:
A. only those lizards with solid green bodies would escape predators and live to reproduce.
B. the lizards would adapt to the change in the environment.
C. the need to survive would cause lizards to change their body color.

Additional items – Answer each item by selecting the best letter for your response. The questions that are response are followed by a series of explanations for the previous question. Select the answer that best describes your explanation or reasoning for the response above it:

13-Response. Which of the following would best describe the theory of evolution?

a. Life on earth is constant and unchanging
b. Life on earth has changed in the past, but is now constant and unchanging
c. Life on earth has changed, is presently changing, and is predicted to continue changing in the future
d. Life on earth has changed in the past but is not likely to change in the future because of human intervention

14-Explanation. What is the explanation or reason for your choice in 1-R, above?

a. My religion believes this to be true.
b. The evidence from the fossil record is so compelling, it must be true.
c. Scientists have interfered with natural processes and have stopped/slowed the evolutionary process.
d. The universe is controlled by a supreme being, not by chance.

15 – Response. Which of the following best explains changes in species over time?

a. organs and structures which are not needed are lost
b. organisms can adapt in order to survive
c. DNA changes which allow certain organisms to compete more successfully
d. Some organisms run out of food and die, while others survive because they migrate to new territory

16 – Explanation. What is the explanation or reason for your choice in 3-R, above?

a. organisms choose to change so that they can survive
b. changes occur randomly, through mutations, that will favor the survival of the organisms with that mutation
c. what is not used is lost, much like information in your memory
d. supply and demand of resources influences survival because resources are what allow organisms to live.

17 – Response. Which of the following best describes Darwin's *Theory of Survival of the Fittest?*

a. organisms must adapt in order to survive
b. only healthy organisms live to reproduce fertile offspring
c. only physically strong organisms live to reproduce fertile offspring
d. the most competitive organisms survive long enough to reproduce offspring

18 – Explanation. What is your explanation or reason for your choice in 5-R, above?

a. change forces nature to select certain organisms so those organisms with adaptations logically will survive
b. organisms that have poor health cannot be considered the "fittest" organisms because they are weak due to illness.
c. Physical strength relates most closely to fitness for survival. The two terms mean essentially the thing.
d. Survival of an organism is directly dependent on that organism's offspring being produced and surviving so that they can carry the genes on to future generations

19 – Response. Charles Darwin is best remembered for:

a. saying that humans evolved from apes
b. his Theory of Natural Selection
c. his work with garden peas
d. describing DNA as the agent of heredity

20 – Explanation. What is your explanation or reason for your choice in 7-R, above?

a. Darwin used peas to explain how genes are passed from generation to generation, thereby influencing the selection of traits
b. Darwin came up with the idea of evolution which, when dealing with humans, is apes eventually evolving in to humans.
c. Darwin observed organisms in the Galapagos Islands, which because it was an isolated geography, allowed him to observe the selection of certain traits among the organisms of those islands.
d. Darwin focused on selection of traits through natural selection and those traits had to be DNA because DNA is the basis for heredity of those traits.

Scoring Instructions

Study of Life Questionnaire Scoring Instructions

Scoring of this test follows the format given in Appendix B of the article written by Rutledge and Warden (1999). The scoring considers negatively and positively phrased statements about evolution by giving a score of 5 to responses that indicate a high acceptance of the theory of evolution and scoring responses that indicate a low acceptance of the theory of evolution with a 1. To score the Study of Life Questionnaire, follow these three steps:

Step 1, Items 5, 7, 9, 12, 15, 16, 20, 22, 24, 25, 26:
Strongly Agree = 5
Agree = 4
Undecided = 3
Disagree = 2
Strongly Disagree = 1

Step 2, Items 6, 8, 10, 11, 13, 14, 17, 18, 19, 21, 23:
Strongly Agree = 1
Agree = 2
Undecided = 3
Disagree = 4
Strongly Disagree = 5

Step 3, Score on the Study of Life Questionnaire is equal to the sum of the responses to all 22 items.

Science Knowledge Questionnaire Scoring Instructions

There are two types of questions present in the Science Knowledge Questionnaire. The first type measures fixed views of science and the second type measures tentative views of science. When analysis of these questions is undertaken, the fixed scale is inverted, so that 1 = 4, 2 = 3, 3 = 2, and 4 = 1, and added to the tentative scale. To score the Science Knowledge Questionnaire follow these three steps:

Step 1, Tentative view Items 29-33, 36, 37, 41:
Strongly Agree = 4
Agree = 3
Disagree = 2
Strongly Disagree = 1

Step 2, Fixed view Items 27, 28, 34, 35, 38-40, 42:
Strongly Agree = 1
Agree = 2
Disagree = 3
Strongly Disagree = 4

Step 3, Score on the Science Knowledge Questionnaire is equal to the sum of the responses to all 16 items. A high score indicates a more tentative view of the nature of science.

Understanding Biological Change Test Scoring Instructions

This test is a two-tiered multiple choice question format exam designed to assess student understanding of biological change. The first 12 questions are two part questions, which require each answer to consist of a number and letter. The last 8 questions will only include a letter. Each student can score as high as 20 or as low as zero with high scores indicating a high level of understanding of biological change. Score using the following answer key:

Answer Key

1) 2A	2) 1B	3) 2A	4) 2C	5) 1A	6) 2C
7) 2B	8) 1A	9) 1B	10) 2C	11) 2C	12) 2A
13) C	14) B	15) C	16) B	17) D	18) D
19) B	20) C				

After checking the test, total the number correct and this is the student score.

REFERENCES

Abd-El-Khalick, F. & Lederman, N.G. (2000). Improving science teachers' conceptions of nature of science: A critical review of the literature. *International Journal of Science Education, 22,* 665-701.

Berkman, M., Pacheco, J., & Plutzer, E. (2008). Evolution and creationism in America's classrooms: A national portrait. *PLOS Biology, 6*(5), 920-924.

Cavallo, A. M. L., & McCall, D. (2008). Seeing may not mean believing: Examining students' understandings & beliefs in evolution. *The American Biology Teacher, 70*(9), 522-530.

Cavallo, A. M. L., White, K. J., & McCall, D. (2011). The mismatch among students' views about nature of science, acceptance of evolution, and evolutionary science understandings. *Science Education Review, 10*(2), 37-42.

Darnell, A., & Sherkat, D. E. (1997). The impact of protestant fundamentalism on educational attainment. *American Sociological Review, 62*(2), 306-315.

de Souza, R. F., de Carvalho, M., Matsuo, T., & Zaia, D. A. M. (2010). Study on the opinion of university students about the themes of the origin of universe and evolution of life. *International Journal of Astrobiology, 9*(2), 109-117. doi:10.1017/S1473550410000054

Ingram, E. L., & Nelson, C. E. (2006). Relationship between achievement and students' acceptance of evolution or creation in an upper-level evolution course. *Journal of Research in Science Teaching, 43*(1), 7-24. doi:10.1002/tea.20093

Lauer, S., Momsen, J., Offerdahl, E., Kryjevskaia, M., Christensen, W., & Montplaisir, L. (2013). Stereotyped: Investigating gender in introductory science courses. *CBE Life Sciences Education, 12*(1), 30-38.

McCall, D. (2004). *Investigating student beliefs about evolution and the nature of science as related to understanding of evolution.* (Unpublished master's thesis). Wayne State University, Detroit, MI.

McKeachie, W. J., Lin, Y., & Strayer, J. (2002). Creationist vs. evolutionary beliefs: Effects on learning biology. *The American Biology Teacher, 64*(3), 189-192. doi:10.1662/0002-7685(2002)064[0189:CVEBEO]2.0.CO;2

Muller, C. B., Ride, S. M., Fouke, J., Whitney, T., Denton, D. D., Cantor, N., . . . Robinson, S. (2005). Gender differences and performance in science. *Science, 307*(5712), 1043-1043.

Norton, S. W., & Tomal, A. (2009). Religion and female educational attainment. *Journal of Money, Credit and Banking, 41*(5), 961-986.

PBS. (2001). *Evolution*. Retrieved from http://www.pbs.org/wgbh/evolution/.

Rutledge, M.L., & Sadler, K. (2007). Reliability of the measure of acceptance of the theory of evolution (MATE) instrument with university students. *The American Biology Teacher, 69*(6), 332-335. doi:10.1662/0002-7685(2007)69[332:ROTMOA]2.0.CO;2

Rutledge, M.L., & Warden, M.A. (1999). The development and validation of the measure of acceptance of the theory of evolution instrument. *School Science and Mathematics, 99,* 13-18.

Ryan, A.G., & Aikenhead, G.S. (1992). Students' preconceptions about the epistemology of science. *Science Education*, *76*, 559-580.

Schilders, M., Boersma, K. T., Sloep, P., & Peled, E. (2009). Worldviews and evolution in the biology classroom. *Journal of Biological Education, 43*(3), 115-120.

Schraer, W.D. & Stoltze, H.J. (1999). *Biology the Study of Life (7th ed.).*Upper Saddle River, NJ: Prentice Hall.

Settladge, J. & Jensen, M. (1996). Investigating the inconsistencies in college student responses to natural selection test questions. *Electronic Journal of Science Education, 1*(1), Retrieved 2/12/14.

Simpson, D. (2008). Sex and gender differences in religiousness and spirituality. *Journal of Psychology and Theology, 36*(1), 42-52.

Willoughby, S., & Metz, A. (2009). Exploring gender differences with different gain calculations in astronomy and biology. *American Journal of Physics, 77*(7), 651-657.

BIOGRAPHICAL INFORMATION

Danielle Carlton is graduating from UT Arlington with an Honors degree in Biology, and she will also be certified to teach Life Sciences as a graduate from the UTeach program. Danielle will be attending graduate school in the fall, and studying Public Health. This project greatly prepared her for graduate school and helped her learn how to conduct and report scientific findings. She hopes to complete research on public health issues in North Texas as she earns her master's degree.