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Exploring how first-year experiences in higher education influence student acceptance of biological evolutionary theory

Lauren A. Winter
University of Northern Iowa

EXPLORING HOW FIRST-YEAR EXPERIENCES IN HIGHER EDUCATION INFLUENCE STUDENT ACCEPTANCE OF BIOLOGICAL EVOLUTIONARY THEORY

An Abstract of a Thesis

Submitted

in Partial Fulfillment

of the Requirements for the Degree

Master of Arts

Lauren Anne Winter

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ABSTRACT

In the current study, I investigated whether changes occurred in the acceptance of evolution for students majoring in elementary education during their first semester of college and if so, what factors influenced the change. Thirty participants in their first semester of college completed pre-and post-tests that included the Inventory of Student Evolution Acceptance to measure changes in student acceptance of evolution over the course of one academic semester. Ten of those participants completed interviews to elaborate on those factors that may have affected their acceptance in evolution. Mixed methods analysis utilizing a cognitive constructivist framework revealed that religious beliefs, explicit evolution instruction in the classroom and discussions with friends were three factors that influenced student acceptance of evolution. Decreased acceptance was often associated with an increase in religiousness in the absence of classroom exposure. Conversely, increased acceptance was often associated with decreased religiousness within the context of discussions with friends and classroom exposure. Although acceptance of evolution changed, most participants had actively assimilated information regarding evolution rather than restructuring their knowledge through accommodation. Implications of the study indicate that in order for conceptual change to take place regarding evolutionary theory, teachers need to be aware of their students' prior beliefs and the factors that may influence their students both inside and outside of the classroom.

Keywords: evolution, acceptance, first-year, college, student

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_____	_____
Date	Dr. John Ophus, Chair, Thesis Committee
_____	_____
Date	Dr. Dawn Del Carlo, Thesis Committee Member
_____	_____
Date	Dr. Jill D. Maroo, Thesis Committee Member
_____	_____
Date	Dr. Kavita R. Dhanwada, Dean, Graduate College

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CHAPTER 1

INTRODUCTION

Various factors affect student acceptance of evolution. This study sought to explore if student acceptance of evolution changes for students in their first semesters of college and if so, to identify those factors that contributed to changes in acceptance. Paz-y-Mino-C and Espinosa (2009) explained that evolution is a significant component to explain the natural world, but only one-fifth of high school graduates accept evolution as a valid theory. A problem arises when only a small percentage of high school students accept evolutionary theory, especially if they plan to attend college and are required to learn about evolution further in order to explain the natural world in which they live. Dobzhansky (1973) proclaimed the importance of evolution to biology when he argued that nothing in biology could make sense without an understanding of evolution. He noted that without the understanding of evolution, biology becomes a mixture of facts without any real connections between them to create a bigger picture.

Evolution explains how the diversity of life on Earth has arisen through descent with modification from an ancestral lineage, and evolution has caused debate and controversy in public school systems across the United States (Wiles & Alters, 2001). Although evolution is a necessary component to understanding biology according to Dobzhansky (1973), many in the public still find it difficult to accept evolution as a valid scientific theory. Even though accepting evolution is not always necessary to understand evolution, not accepting evolution may prevent people from learning the necessary concepts to understand the basic nature of biology.

Biology is a required science class in most high schools, yet people object to the teaching of evolutionary theory for various reasons, which may include the perceived conflict between evolution and religion (Wiles & Alters, 2011). The public objection to evolution education affects teachers and students within high school classrooms and may disrupt potential learning, even if instruction aims to combat common evolution misconceptions. Students are entering college with a low level understanding of evolution and it is typically because students in high school receive limited exposure to evolution instruction (Chinsaymy & Plaganyi, 2007). Because of the imbalanced or limited presentation of evolution in the classroom, combined with the public debate surrounding the controversy of evolution, students may enter college science classes with misconceptions that affect their future learning of important concepts and processes (Chinsamy & Plaganyi, 2007).

Various factors affect a student's acceptance of evolution (Wiles & Alters, 2001). Those factors also affect a student's open-mindedness to learning about evolution in class. Some of the influential factors include religion, such as the perceived conflict between evolution and the teachings of Christian religion. Other scientific factors include how well students understand essential science concepts, which underlie the mechanisms of change in evolution. Non-religious, non-scientific factors also affect a students' openness to accepting or rejecting evolution. These factors include: personal relationships, emotions from perceived consequences, critical thinking, cognitive dispositions, and academic standing (Brem, Ranney & Schindel, 2003; Chinsamy &

Plagany, 2007; Wiles & Alters, 2001). Evolution education can mitigate some of the influential factors, but other factors extend beyond what is taught in the classroom.

Studies have investigated the effectiveness of explicit instruction on evolutionary theory and its ability to change students' acceptance of evolution through different interventions. Some studies found that instruction can be successful (Ingram & Nelson, 2006; Wiles, 2014; Wiles & Alters, 2011), while others found that instruction is not always successful unless it confronts the evolution misconceptions that students hold (Alters & Nelson, 2002). In order for students to realize their misconceptions and move beyond them to learn more accurate information, students need to engage in conceptual change, something that more knowledgeable people typically facilitate, such as classroom teachers (Kim, 2001; Limon, 2001).

Previous studies have addressed the non-scientific, non-religious factors that are not directly influenced by explicit instruction in the classroom, but have failed to directly investigate these factors to determine their impact on evolution acceptance. Research has shown that first-year students in higher education can be affected by changes within personal relationships, religious involvement, and emotions as they transition to a new learning environment (Bryant, Choi, & Yasuno, 2003; Clark, 2005; Smith, Carmack, & Titsworth, 2006) and these experiences could affect their subsequent acceptance of evolution. These students also have the potential to carry misconceptions regarding evolution from high school and from interactions with parents and the media depending on their prior exposure to evolution. Evolution misconceptions may directly impact first-year students' abilities to effectively learn about evolutionary theory. In addition, the

varying experiences that students encounter while transitioning to college during their first semester may also influence student acceptance of evolution.

The purpose of the current study is to identify and explore how college students' first-year experiences influence their acceptance of evolution. This mixed methods study will examine if changes of student acceptance of evolution occur and if so, to identify the experiences that influenced students.

CHAPTER 2

LITERATURE REVIEW

Background

Students entering the college environment for the first time often encounter many changes that are different compared to their experiences in high school. Some of these experiences may include: social support, developing independence, as well as identity formation (Bowman & Brandenberger, 2012; Clark, 2005; Smith et al., 2006). These different experiences may impact a first-year student's acceptance of evolutionary theory because of interactions with some of the various factors that influence student acceptance of evolution including: religiousness, scientific factors, as well as non-scientific, non-religious factors. Students experience changes during their first year of college and those changes may influence the factors linked to evolution acceptance.

First-year Experiences

First-year students entering higher education encounter different experiences that may affect their identity formation as well as their attitudes and beliefs as they integrate into the novel setting of college (Azmitia, Syed & Radmacher, 2013; Bowman & Brandenberger, 2012). Many of the students leave home for the first time, abandon past friendships, and learn to build new social support structures (Clark 2005, Smith et al., 2006). Students also learn to deal with their new independence, while maintaining a balance between forming some interdependence through social support. The diversity experiences that first-year students encounter may encourage students to alter their current identities while also strengthening the identities that they bring with them to

college (Smith et al., 2006). All of these experiences that students encounter occur within the context of learning, another influential experience that may challenge students' identities, beliefs, and attitudes.

Social support. The development of friendships and social support are one of the main influences a student encounters when entering a new environment. Clark (2005) reported that becoming socially integrated into the college setting is one of the biggest challenges traditional students entering college experience. Students experience different interactions because of their current social identities and their perceptions of friendship that they bring to college. These prior views affect the types of friendships that students form with one another. One of the continuous themes students encountered was the necessity to adapt to change. Students noted that they would have to adapt to changes within the classroom, including new expectations from professors, and that dealing with each class required different strategies and approaches to be successful (Clark, 2005). The social support from friends helped students deal with the challenges they faced in adapting to college life.

Kelly, LaVergne, Boone, Jr. and Boone (2012) also acknowledged the importance of developing social structures for student adjustment and persistence in the transition to college. Students' personal characteristics, prior experiences, and commitments often predicted student persistence in college. The social support students receive from peers, family members and significant others, is a form of a commitment. The commitment will make it more likely that students can deal with assimilation into the social settings of college and also encourage students to persist rather than withdraw after their freshman

year (Kelly et al., 2012). The friendships that students develop will shape their adjustment to college and students will strengthen those relationships as they encounter other experiences while navigating the first year.

Buote et al. (2007) added that students first seek out friends that have the same interests, values, and experiences as themselves because students believe it will be the foundation for a good friendship. After the development of friendships based on those characteristics, they will become more intimate. Students begin to self-disclose more personal information such as family issues and belief systems. The intimacy among friends will deepen and strengthen the friendship and further influence a students' adjustment to college both inside and outside the classroom.

Developing independence. Research has also shown that the transition to college not only results in students seeking new support systems, but also moving away from past support systems (Smith et al., 2006). Students often alter characteristics of themselves or their behaviors to ensure that they fit in with different social groups as they form new support systems (Azmitia et al., 2013). As students move away from dependency on their parents and past experiences, they begin to learn from peers with different backgrounds (e.g., religion, culture), which often results in personal growth. Students will usually become more open-minded to new experiences and become more understanding of diverse viewpoints (Smith et al., 2006).

In a study examining over 3,000 students at 50 different postsecondary institutions, Bryant et al. (2003) found that student religiousness typically declines during the first year of college. Within the context of the study, the authors defined

student religiousness as including attendance at religious services, the discussion of religion, participating in religious clubs and groups, and engaging in prayer or meditation. The authors hypothesized that declines in student religiousness occur because students move away from home and their parents are no longer regularly encouraging them to attend church or pray (Bryant et al., 2003). Cultural views and diverse viewpoints often inundate first-year students because of new friendships with diverse peers and the loss of regular contact with parents. Because of these experiences, students become less religiously involved, resulting in lower attendance at religious services, a decrease in discussing religion with others, and also a decrease in the frequency of prayer.

Similarly, Koenig (2015) studied changes in church attendance, importance of religion, religiousness and spirituality for 224 participants during emerging adulthood. The participants' mean age was 19.2 years and they reflected on their retrospective and current religiousness (religion defined as a belief in a higher power, participating in behaviors consistent with religious beliefs and involvement with a religious institution). Koenig found that emerging adults decreased in their religiousness significantly, with 42.33% decreasing in total religiousness. Stoppa and Lefkowitz (2010) explained that this decline in religiousness occurs during emerging adulthood because it is one of the most intensive periods for identity exploration. Emerging adults examine abstract ideals and their purpose, both existentially and religiously. First-year students between the ages of 17-19 with various religious backgrounds took questionnaires during their first three semesters of college (fall, spring and the following fall) to examine their behavior

associated with religion as well as their religious beliefs in terms of importance. The results revealed that students attended religious services 1.6 times a month during their first semester and that number decreased to less than one time a month during the third semester (Stoppa & Lefkowitz, 2010). Participants also reported a decrease in attendance at religious activities outside of church services. Although student attendance at religious activities declined, they maintained their conviction in the importance of their religious beliefs during the first three semesters of college. Stoppa and Lefkowitz (2010) asserted that early in their college experiences, students have more opportunities to make their own decisions that may differ from their families. Additionally, students can encounter influences from the social context of college in which they experience polarizing effects based on the friendships they form.

College provides greater freedom and it allows emerging adults to cease previous activities that they might value as uninteresting or unimportant based on their peers' perceptions. Using data from Waves I and III of the National Longitudinal Study of Adolescent Health, Uecker, Regnerus and Vaaler (2007) examined the sources of religious decline during emerging adulthood. Of those surveyed, 69% decreased in their attendance at religious services, although only one in six reported disaffiliation from their religion. The authors explained that the decline could be due to factors associated with the lives of emerging adults such as orientation to the young-adult life, collective norms in social settings and responsibilities or opportunities that overshadow religious participation. Hayward and Krause (2013) also found that a rapid decrease in religious attendance occurred during the period of transition from adolescence to young adulthood

(15-25 years of age). They claimed that the declines could be due to the reduced importance of religion during that period, the lack of parental influence after students leave home and other life transitions that occur during that time.

Identity formation. As students develop independence from their lives at home, they restructure their identity to fit within peer groups to which they identify (Kaufman, 2014). Students will often challenge their beliefs and values, which can impact their academic success (Bowman & Brandenberger, 2012). Experiences with diversity in the first year of college, whether it is racial/ethnic diversity or diverse points of view, can shape and have a lasting impact on students' attitudes and beliefs. When students experience things that conflict with their prior attitudes and viewpoints, commonly referred to as disequilibrium, cognitive growth can, but does not always occur (Bowman & Brandenberger, 2012). When the conflict occurs, students can either make sense of the experience using their current beliefs, in which no cognitive growth occurs, or they can change their viewpoints to incorporate the new information they have learned. Students need the time and energy to reflect on confronting issues and students may reshape their attitudes after the presentation of additional information. Although attitude change occurs, students are often unaware of the change.

Azmitia et al. (2013) also noted that transitioning to college could encourage emerging adults to adjust their identities, which is especially salient for those who move away from their family and friends. The new context that college provides often necessitates that emerging adults change their identity within the new support networks that complement their existing ones. The support networks within the college setting

extend to new peers, staff and faculty who instill a sense of student importance within the new college community (Azmitia et al., 2013). As Kaufman (2014) described, college is an important place where students work to find consistency between their personal identities they bring to college but also their social identities they develop while interacting with others. Often, students in college will merge their identity and embrace the attitude of the group to which they want to belong, creating a more complete sense of themselves.

Student Acceptance of Evolution

The general public's ability to accept evolution is often a difficult task because they perceive obstacles to accepting evolution. Thagard and Findlay (2010) noted that people often deal with both cognitive and emotional obstacles when attempting to accept evolution. People may experience cognitive struggles because they may not understand and grasp the many different concepts that describe the process of evolution.
It can also be difficult for people to understand how or why they should believe that evolution is a valid theory.

Accepting evolution can also present emotional obstacles. The perceptions that evolution undermines free will; something given freely by a caring God is one obstacle to acceptance (Thagard & Findlay, 2010). Evolution is a spontaneous process that occurs and does not happen because it would benefit one particular species over the other, therefore, removing the necessity for free will. A second emotional obstacle includes political beliefs and affiliations (Thagard & Findlay, 2010). Some people struggle to accept evolution because their particular political party does not accept evolution. The

different obstacles that people face when dealing with the decision to accept evolution can influence how they also discuss evolution with others around them. These discussions can directly affect students who will face learning about evolution within the classroom.

Students often hold varying attitudes and beliefs regarding evolutionary theory as a result of misconceptions they have developed previously in school (Wiles & Alters, 2011). Students' prior evolution misconceptions often affect their tendency to accept evolution, which is a general problem for student achievement of the content. Accepting evolution means that students assess the validity of the theory based on evaluating evidence and choose to confirm the validity (Wiles & Alters, 2011). Chinsamy and Plaganyi (2007) conducted a study examining attitudes pertaining to learning about evolution among first-year college students. The researchers surveyed the students on attitudes about evolution before and after students participated in 16 lectures about evolution. Results showed that there were no significant changes in the attitudes about evolution before and after exposure to the topic (Chinsamy & Plaganyi, 2007). Some of the factors that affected students' resistance to accept evolution were strong religious views and also the lack of understanding of evolution concepts before entering the course because of prior misconceptions.

Religiousness. Many students struggle with the acceptance of evolution because of their religious beliefs (Blackwell, Powell & Dukes, 2003; Manwaring, Jensen, Gill & Bybee, 2015; Wiles, 2014; Wiles & Alters, 2011). Students typically believe that evolution and religion are either completely separate and explain different aspects of the

world, incompatible dichotomies that conflict with one another or integrated, meaning that they address the same things and can coexist. Although students perceive potential incompatibilities between their religion and evolution, most religious groups are at least somewhat accepting of evolution and do not perceive conflicts between evolutionary theory and their religious teachings (The Pew Research Center, 2014). After surveying 13 religious groups, only two (Lutheran Church-Missouri Synod and Southern Baptist Convention) noted incompatibilities between their religious teachings and evolution resulting in their rejection of evolution (The Pew Research Center, 2014). Students who reject evolution based on Christian religious beliefs may do so because they believe the literal interpretation of the creation story in the book of Genesis in the Christian Bible. The creation story is at the core of a person's religious beliefs, and it explains how God created man (Blackwell et al., 2003). Because evolution explains how man descended from a common ancestor, rather than through creation from a higher being, students view evolution and religion as incompatible entities.

Usually, when students feel that evolution and religion are incompatible, they find it difficult to accept evolution compared to students who believe that evolution and religion are either separate or integrated ideas. Students will believe that because the two ideas are in direct conflict with one another, they have to abandon one of their beliefs, and usually, students will abandon evolution (Wiles & Alters, 2011). This misconception regarding the relationship between religion and evolution will lead to resistance to learning and accepting evolution in the future (Wiles & Alters, 2011).

Wiles (2014) examined factors that influenced student acceptance of evolution by interviewing gifted students in a public secondary education setting. After students learned about evolution from a variety of methods including discussions, videos and inquiry activities, Wiles (2014) found that students either became more accepting or more rejecting of evolution. The students who became more accepting had become more open-minded about their religious interpretation or considered the evidence for evolution more openly. They also learned to accept new ideas from those people who held differing viewpoints (Wiles, 2014). The students who rejected evolution referred to their religious beliefs and asserted that they followed "The Bible" or they were raised not to believe in evolutionary theory.

Manwaring et al. (2015) examined the acceptance of evolution with a population of Latter Day Saints at Brigham Young University to determine the influence of religion on student acceptance. Participants completed questionnaires that measured their understanding of evolution, religiosity, understanding of their religious doctrine's positions on evolution as well as student acceptance of evolution. Students completed the questionnaires prior to learning about evolution in an introductory biology course for non-majors and then again after the course ended. The authors found that prior to the course, 22.7% were supportive of evolution and after the course, 56.7% had become more supportive (Manwaring et al., 2015). They found that religiosity influenced students' initial willingness to accept evolution but that it did not provide a barrier for them to increase their acceptance. As the students learned more about their religion and its doctrine on evolution, the acceptance rates of evolution increased.

Scientific factors. There are also factors, both scientific and non-scientific, that are not associated with religion, but continue to influence acceptance of evolution (Alters & Nelson, 2002; Cunningham & Westcott, 2009; Nadelson & Hardy, 2015). Misconceptions in basic science knowledge are scientific factors that affect evolution acceptance. Students lack an overall understanding of evolution because they do not accept the evidence for evolution, or understand how evolution occurs through mechanisms of change (Cunningham & Westcott, 2009). A general lack of knowledge in the nature of science also contributes to misconceptions regarding evolution. Students often make vernacular misconceptions and confuse the scientific terminology of evolution with words that have different meanings when used everyday. For example, students will often say that "evolution is just a theory" because they incorrectly interpret theories as guesses to explain something and think that theories are not as powerful as scientific laws (Alters & Nelson, 2002). The importance of a theory is typically a critical component of the nature of science and if students lack that basic knowledge, it can affect how they view more complex concepts and processes such as evolution.

Trust in science and scientists are also science-based factors that affect the acceptance of evolution. Nadelson and Hardy (2015) surveyed 159 participants with a mean age of 19.39 at a large university. Participants completed a demographic questionnaire as well as the I-SEA and a Trust in Science Survey. The authors found that trust in science correlated positively with acceptance of evolution. They explained that trust in science is related to understanding the nature of science and mistrust in science results if someone misunderstands how science works. Often, mistrusting science and scientists leads to a

rejection of the work of scientists, such as the theory of evolution (Nadelson & Hardy, 2015).

Non-scientific, non-religious factors. Wiles and Alters (2011) explained that there are also non-scientific, non-religious factors that affect acceptance of evolution. One influential factor is personal relationships, including relationships with parents, teachers, and friends (Donnelly, Kazempour, & Amirshokoohi, 2009). Students will often appeal to authority and make decisions on whether or not they will accept evolution and it can change their attitudes depending on whom they view as authorities. Donnelly et al. (2009) assessed the acceptance of evolution of high school biology students. After completing the Measure of Acceptance of the Theory of Evolution (MATE) as well as interviews, the results revealed that 11 students accepted evolution and 18 rejected evolution. The authors found that the participants who accepted and rejected evolution often attributed their choices to the views of their parents and what they learned in their homes.

Perceived consequences of accepting evolution. Perceived consequences from accepting evolution can also influence how students view and learn about evolution (Brem et al., 2003). In particular, people who reject evolution do so because they think it could lead to negative personal and social consequences for themselves and others. Brem et al. (2003) asked participants to write down their thoughts regarding evolution and some common beliefs included that accepting evolution could lead to: “an increase in selfishness and racial discrimination, and a decrease in sense of purpose, feelings of self-determination, and spiritual beliefs” (Brem et al., 2003, p. 194). The researchers posited

that accepting evolution for some people could result in those negative consequences because evolution might introduce ideas of competitiveness among species, and also highlight racial differences among people. It could also lead to a loss of self-determination and sense of purpose because evolution does not require a supreme being for nature to take its course and modifications can occur at random.

Although some people may perceive negative consequences for accepting evolution (Brem et al., 2003), research has also shown that growth in critical thinking, open-minded cognitive dispositions and higher academic standing could lead to higher rates of acceptance of evolution (Wiles & Alters, 2011). Deniz and Donnelly (2011) measured the understanding of evolution, acceptance of evolution and the epistemological beliefs and thinking dispositions of 32 preservice secondary science teachers at a Midwestern university. They found a significant correlation between epistemological beliefs and evolution as well as a correlation between thinking dispositions and acceptance. They posited that thinking dispositions such as openness to change and cognitive flexibility are more likely to lead to acceptance of evolution because those characteristics are associated with the consideration of alternative opinions and evidence.

Theoretical Framework

Educators who hold a constructivist viewpoint for learning assume that students are not passive receivers of knowledge, but rather, learners who construct their own knowledge based on new experiences they encounter as well as the prior experiences that they encountered in the past (Driver, Asoko, Leach, Mortimer, & Scott, 1994). The

results of this study were analyzed and interpreted within a cognitive constructivist framework.

Cognitive constructivists acknowledge that learning occurs within an individual as they personally process information to build on prior knowledge (Powell & Kalina, 2009). People do not learn solely as individuals, however. According to cognitive constructivism, teachers, peers, parents and other people who influence an individual facilitate assimilation and accommodation, processes in which people learn new information. Assimilation and accommodation are cognitive processes that occur internally within individuals as they make sense of new information (Powell & Kalina, 2009).

Derry (1996) noted that individuals use their existing knowledge structures to make sense of the world around them. If previous knowledge is not sufficient to understand something new, individuals will experience disequilibrium and it causes them to adjust information so that it aligns with what they are currently experiencing. Opportunities that encourage potential disequilibrium will be more likely to promote assimilation and accommodation so that the reconstruction of knowledge can begin (Derry, 1996). The various changes and new encounters students experience as they transition to adulthood during their first semester of college, may provide opportunities for disequilibrium to occur. The development of new friendships, increased independence, the formation of an altered identity and classroom experiences, may present students with opportunities to reconstruct their previous knowledge. Although these experiences will likely involve social interactions, the assimilation and accommodation that takes place will occur within

the individual as he or she processes the new information that conflicts with previous knowledge (Derry, 1996).

Within the science classroom, teachers assist students as they construct their own knowledge by providing direct experiences for students and also giving them the opportunity to interact with and understand the conventions of a scientific community (Driver, et al., 1994). Students hold prior thoughts and commonsense knowledge that are often developed informally outside of the classroom as a result of personal culture. Students bring those ideas with them when they enter science classrooms and some of these thoughts are misconceptions. Misconceptions are false opinions or attitudes of the information that students learn and they can form misconceptions in different ways (Alters & Nelson, 2002). Individuals develop misconceptions based on previous experiences, attempting to construct new knowledge to fit within current beliefs, or they can learn information informally from parents and the media that is not factual in nature (Alters & Nelson, 2002). Evolution misconceptions develop in the same ways mentioned previously (Alters & Nelson, 2002).

Conceptual Change

Learning science from a constructivist perspective typically involves some form of conceptual change. Conceptual change involves learning in which, "the pre-instructional conceptual structures of the learners have to be fundamentally restructured in order to allow understanding of the intended knowledge," (Duit & Treagust, 2003, p. 673). Students' commonsense knowledge and beliefs need to change so that students can appropriately construct knowledge as they learn new information in the classroom.

Alters and Nelson (2002) offered insight into the necessity for students to change specific misconceptions when learning in the classroom because of the effect of misconceptions on future learning. Students' prior ideas affect how and if students will learn new concepts if the prior ideas are inaccurate (Alters & Nelson, 2002). A core tenet of this type of conceptual change assumes that the prior knowledge is incorrect or misunderstood, whereas the new information is "correct" according to a standard. Thus, the prior knowledge conflicts with the new information and creates a barrier to learning (Chi, 2008).

In order to engage students in conceptual change, the teacher should know students' current beliefs about knowledge and potential misconceptions so that he or she knows how students' current knowledge needs to be reconstructed to allow for future learning (Chi, 2008). In order to successfully assist students with conceptual change, the learner must reject his or her old conception and also believe that a new conception is plausible before accommodating the new conception. In cases where prior knowledge is incorrect and contradict the "to-be" learned information, the convictions are often refuted either implicitly or explicitly to result in revisions (Chi, 2008). To counteract misconceptions, instructors need to realize that students are dealing with misconceptions, determine what the misconceptions are, provide experiences contradictory to the misconceptions, and then evaluate if the students have made changes in their learning beliefs (Limon, 2001).

Past research demonstrates that engaging students in conceptual change and encouraging them to abandon their prior knowledge is often a difficult task. Typical instructional strategies such as using lecture and textbooks are ineffective in facilitating

necessary conceptual change in the science classroom (Guzzetti, 2000). Although traditional teaching strategies are ineffective ways to induce conceptual change, an effective instructional approach in which to apply the conceptual change is within inquiry-based learning.

Timmerman, Strickland, and Carstensen (2008) found that in classrooms employing inquiry-based learning compared to traditional learning, inquiry-based learning encouraged students to make connections between knowledge and drawing conclusions, and this metacognition is necessary for conceptual change to occur effectively. This form of inquiry-based learning in which students make connections between content and experience will often challenge students to examine their prior attitudes and misconceptions and this can result in changes in attitudes and beliefs after instruction (Timmerman et al., 2008). Students bring common misconceptions with them from high school as they enter college, and instructors need to address those misconceptions to facilitate future learning.

Research examining the acceptance of evolution typically focuses on how instruction that emphasizes evolution within schools can change student misconceptions and attitudes toward evolution through conceptual change. As Wiles and Alters (2011) noted, there are also other factors that typically influence whether or not someone will accept evolution and they extend beyond explicit instruction on evolution. Because misconceptions affect the potential for meaningful learning to occur (Alters & Nelson, 2002), it is important that conceptual change requires that misconceptions are altered. Evolution instruction can change student misconceptions of evolution, which might result

in increased acceptance (Wiles & Alters, 2011). It is also possible that other outside factors could engage students in conceptual change, in which they confront their misconceptions and begin to accommodate new information regarding evolution (Wiles & Alters, 2011).

Research on the acceptance of evolution does not directly assess how other outside factors, such as personal relationships, emotions from perceived conflicts, and independence and diversity experiences with new cultures in college, may affect students' acceptance of evolution. The connection between evolution acceptance and these factors is also lacking in the first year of college when these experiences are especially salient for students. The current study aims to explore the different experiences that may affect student acceptance of evolution during the first year of college and is not limited to the experiences previously mentioned.

Research Questions

1. How do college students' first-year experiences influence their acceptance of evolution?
2. What first-year experiences influence changes in student acceptance of evolution?

CHAPTER 3

METHODS

The current study utilized a mixed-methods approach in order to fully address both research questions. Specifically, an explanatory sequential mixed methods approach was used. Creswell (2014) explained that with this method, quantitative data is collected first, and the qualitative data is collected after to build upon the results from the quantitative data analysis. This method is considered more explanatory because the qualitative results support and further explain the quantitative data.

I utilized quantitative methods to determine the initial and final measurements of student acceptance of evolution followed by qualitative methods to identify the different experiences that may have impacted students' acceptance of evolution. Johnson, Onwuegbuzie, and Turner (2007) justified the potential benefits of using a combination of quantitative and qualitative methods to answer research questions. One potential benefit is that by using different methods, the data can support one another through confirming the results, thus, increasing the reliability of the data. A second potential benefit for using a combination of methods is to enable richer data analysis. Therefore, the data analysis using multiple methods provides a more thorough and well-rounded explanation for changes in student acceptance of evolution rather than relying on one type of method alone.

Participants

Recruited participants (N = 251) consisted of students enrolled in inquiry-based content courses (either physical science or life science), which are required for

elementary education majors at a midsized university in the Midwest. I selected the inquiry courses as the sample because each of those courses has a freshman-only designated section and the research questions focus on students in their first year of college. Participants who took only one inquiry-based science course during the semester were considered eligible for the study, so that it can be assumed that primarily all science content learned during the first semester was attributed to enrollment in one of the two inquiry courses.

Because participants only received science content from one course, those in inquiry into physical science did not receive explicit instruction on the theory of evolution during their first semester of college, as it is not included in the curriculum. Thus, the hypothesis posited that their potential changes in the acceptance of evolution could be attributed to other experiences besides explicit instruction. Participants in inquiry into life science, however, received explicit instruction on the theory of evolution during their first semester of college as part of the class curriculum. Therefore, it was assumed that their potential changes in the acceptance of evolution were more likely credited to explicit instruction on evolution. It is assumed that participants in the life science course would be more likely to confront their prior misconceptions regarding evolution and undergo conceptual change because they have been confronted by these misconceptions in an inquiry setting (Timmerman et al., 2008).

Materials

Participants (n = 126) completed two tests, pre and post semester. Both the pre- and post-tests included the full set of questions from the Inventory of Student Evolution

Acceptance (I-SEA; Nadelson & Southerland, 2012; Appendix A) in order to measure participant acceptance of evolution. The I-SEA is a 24-question assessment that focuses on evolutionary theory, including a breakdown of statements regarding macroevolution, microevolution, and human evolution. Each question consists of a five-point Likert-like scale that requires participants to choose their level of agreement or disagreement with each question. Eight of the questions required reversed scoring (Appendix A). Participant scores can range from 24 to 120, with lower scores indicating non-acceptance of evolution.

Nadelson and Southerland (2012) field tested the I-SEA with both high school and university students and found it to have a composite Cronbach's alpha value of 0.95. All items of the instrument have high reliability as well as the individual subscales. The researchers consulted nine university biology faculty who classified the items into the different subscales independently and confirmed the validity of the instrument. The I-SEA allows for a refined examination of student acceptance of evolution with respect to the different components of evolution acceptance. Additionally, the instrument serves as an intervention tool to assess pre- and post-test measures of student evolution acceptance after formal and informal evolution instruction.

A demographic survey (Appendix A) preceded the I-SEA to gather data about each participant including current enrollment in an inquiry course, year of high school graduation, college major, and the number of science courses previously taken, in case those became important controlling factors that influenced evolution acceptance during the first semester. Because of its inclusion within another IRB approved study, the pre-

test also included questions about religion, Biblical literalism and evolution acceptance. I excluded those additional questions from the data analysis for this study. The post-test included the same demographic questions as the pre-test as well as eight additional open-ended questions that allowed participants to elaborate on some of their first-semester experiences (Appendix B). The questions about religion, Biblical literalism and evolution acceptance were not included on the post-test.

After participants completed a pre- and post-test, I selected a subset of participants (n = 15) based on their responses. I conducted semi-structured, follow-up interviews (Appendix C) to identify common experiences that may have affected student acceptance of evolution during the first semester of college.

Procedure

The institution's Institutional Review Board approved all procedures used for the study (Appendix D) prior to participant recruitment and subsequent data analysis. Participants (N =251) enrolled in the inquiry into physical science and life science courses completed the pre-test during the first week of classes in the Fall 2014 semester. Recruited participants completed the pre-test online using Qualtrics survey software. Participants provided consent before taking the pre-test (Appendix E). A member of the research team unaffiliated with the participants recruited the participants and oversaw their participation. The score indicated a pre-test measure of the participants' acceptance of evolution early in their exposure to the college environment.

Participants (n = 126) enrolled in either the life science or physical science courses completed the post-test during the last week of regularly scheduled classes in the Fall

2014 semester. Again, the participants participated during class, and the post-test utilized Qualtrics. A member of the research team unaffiliated with the participants recruited them and oversaw their participation in the research. The score served as a post-test measure of participants' acceptance of evolution theory later in their transition to college.

Following the completion of the fall semester, I scored and analyzed the results of the I-SEA to determine a change in acceptance of evolution from the beginning of the semester to the end. Analysis included frequency counts to determine the number of participants who changed their acceptance, including increases, decreases and those who did not change. Non-first-year students (n = 80) were excluded from the remainder of the study to retain the focus on first-year student experiences. The scores of participants enrolled in more than one inquiry course (n = 3) during the fall semester were excluded to eliminate any confounding influence from additional exposure to varied science curriculum.

Based on the differences between the pre- and post-test scores and responses to the open-ended questions, a subset of participants who increased their acceptance of evolution, did not change their acceptance and those who became less accepting of evolution were identified and selected. Because the I-SEA does not contain levels for scores regarding acceptance and non-acceptance of evolution, an increase in acceptance of evolution was based on any numerical increase between pre- and post-test and a decrease in acceptance was based on any numerical decrease between the two survey administrations. Fifteen participants were asked to participate in audio taped interviews during the Spring 2015 semester. I contacted the participants via the email they provided

on the post-survey and 10 participants agreed to participate in interviews. I met with each participant in a public location, provided a consent form (Appendix F) and conducted the interview, recording the audio file using QuickTime. Following the completion of the interview, I provided each participant with a $50 Amazon gift card as compensation for participation.

The interviews provided first-hand, participant accounts of experiences that influenced student acceptance of evolution during the first semester of college. The interviews allowed participants to expand on their answers to the post-test and also highlight any influential experiences in their change, resistance to change or no change regarding the acceptance of evolution.

After completion of the interviews, I de-identified all participant data to maintain the confidentiality of the participants. I transcribed the audio recordings for each participant and assigned each interviewed participant a synonym for future reference. I analyzed the transcripts and coded them into categories using NVivo 11 (QSR International, 2015) to identify the different factors that affected participant acceptance of evolution during the first semester of college. The categories included: *religiousness, evolution instruction, discussions with friends, experiences with diversity, discussions about evolution,* and *maintaining contact with parents.* I conducted additional quantitative analysis of the scores on the I-SEA to examine the differences between the mean scores for the participants overall, as well as the differences on the pre and post-tests between the two populations studied. I also utilized an independent samples t-test assuming unequal

variances to determine if the mean differences between the participants in IiPS and IiLS were significant.

To improve internal validity of the study, another member of the research team examined the participant transcripts to confirm the categories used during coding and to confirm potential experiences that were influential for a number of participants. Additionally, methodological diangulation was utilized to identify participant changes in student acceptance of evolution. The pre-and post-score results of the I-SEA provided one way of determining if student acceptance of evolution changes, but the participant interviews also provided information as to whether acceptance changed based on self-reporting.

I was employed as a teaching assistant by the institution at which the research was conducted and was assigned to some of the participants' science content courses. To reduce coercion during recruitment, I was not directly involved in the initial recruitment of participants or the subsequent recruitment to complete the post-test. I was responsible for recruiting participants and conducting their interviews, but that did not take place until after the fall semester ended and the participants were no longer students in my courses. In my role as a teaching assistant, I had limited contact with some of the participants prior to their interviews during classroom interactions. Although I was familiar with some of the participants, I followed the same protocol with all participants when conducting interviews to maintain consistency. Additionally, I de-identified participant data following the interviews to reduce any potential bias.

CHAPTER 4

RESULTS

Participants completed a pre-test and post-test indicating their acceptance of evolution prior to their first semester of college and following the completion of their semester, respectively. Initially, 251 participants completed the pre-survey and 126 of those participants also completed the post-survey. Of the 126 participants who completed both the pre-and post-survey, 30 were students in their first semester of college and registered students in only one of the Inquiry courses: Inquiry into Life Science (IiLS) (n = 16) or Inquiry into Physical Science (IiPS) (n = 14). I analyzed the pre- and post-scores of the 30 participants to organize participants into three groups: those who increased their acceptance of evolution, decreased their acceptance of evolution or did not change their acceptance over the course of the semester. Approximately 63% of those participants increased their acceptance, 30% decreased their acceptance and 7% did not change their acceptance (Table 1).

Table 1

Number of Participants and Types of Change in Acceptance of Evolution

Types of Change	No. of Participants	% of Participants
Increased Acceptance	19	63.33%
Decreased Acceptance	9	30.00%
No Change in Acceptance	2	6.67%

More participants (n = 19) from both classes increased in their acceptance compared to those who decreased their acceptance (n = 9) (Table 1). However, more participants in IiPS decreased their acceptance, and by a wider range of scores compared to the participants in IiLS who decreased their acceptance (Table 2). The participants in IiPS changed their scores from a range of -36 to 17, whereas the change in participants' scores in IiLS ranged from -20 to 19. Although the participants in IiPS did not receive any evolution instruction in the classroom, they still increased their acceptance within a similar range of scores compared to participants in IiLS, and had changes that occurred over a wider range than those participants in IiLS who did receive instruction.

Table 2

Participants' Changes in Scores Between the Pre and Post-Tests

Class	Pre-Test Score	Post-Test Score	Changes in Scores
IiLS	92	91	-1
IiLS	63	59	-4
IiLS	81	71	-10
IiLS	83	63	-20
IiLS	92	93	1
IiLS	93	95	2
IiLS	91	93	2
IiLS	105	107	2
IiLS	80	82	2
IiLS	95	98	3
IiLS	90	93	3
IiLS	88	92	4
IiLS	89	95	6
IiLS	70	89	19
IiLS	95	95	0
IiLS	88	88	0
IiPS	77	70	-7
IiPS	95	86	-9
IiPS	64	34	-30

(table continues)

Class	Pre-Test Score	Post-Test Score	Changes in Scores
IiPS	78	42	-36
IiPS	91	53	-38
IiPS	76	77	1
IiPS	118	120	2
IiPS	83	86	3
IiPS	94	97	3
IiPS	57	62	5
IiPS	80	90	10
IiPS	83	94	11
IiPS	93	105	12
IiPS	52	69	17

The means for the pre and post-test scores for the 30 participants revealed that only a small decrease in acceptance occurred between the start of the semester and the end (Table 3). Further analysis of the means for the pre and post-test scores separated by class revealed that the participants in IiLS started at what may be interpreted as a higher level of acceptance when compared to those in IiPS (it may not be higher, but this cannot be determined using the I-SEA), and the participants in IiLS did not experience notable changes in their acceptance throughout the semester (Table 3). The participants in IiPS started at a lower level of acceptance and notably decreased their acceptance over the duration of the semester when compared to those in IiLS.

Table 3

Mean Scores for the Pre-Test and Post-Test

Class	Pre-Test *M*	Post-Test *M*
Both (*n* = 30)	84.28	82.97
IiLS (*n* = 16)	87.19	87.75
IiPS (*n* = 14)	81.50	77.50

Because of the large range in scores and the presence of outliers between the two populations, I examined the mean difference in scores between the pre and post-tests (Table 4). The mean score for the participants in IiPS varied over a greater range than participants in IiLS. Equal variances were not assumed while conducting an independent samples t-test because the Levene's Test for Equality of Variances revealed a significant difference between the two populations. The t-test revealed that the mean differences between the two classes were not significant ($t(17.40) = .87$, $p > .05$).

Table 4

Mean Differences Between Classes

Class	*M*	Std. Deviation
IiLS (*n = 16)*	.563	8.00
IiPS (*n = 14)*	-4.00	18.1

Based on the initial analysis and frequency counts, I identified a subset of 15 participants from the three groups and ten agreed to interviews during the Spring 2015 semester (Table 5). The selected participants demonstrated various changes in their scores from the pre-survey to post-survey and the two recruited populations were represented in the interview group. Some participants experienced larger changes in their scores than others, but a change in score of at least one point in either direction was qualified as a change in acceptance.

Table 5

Pre and Post-Scores of Interviewed Participants

Participant Name	Pre-Score	Post-Score	Change	Class
Adeline	93	95	Increase	IiLS
Anna Mae	95	95	No change	IiLS
Danielle	83	63	Decrease	IiLS
Jane	89	95	Increase	IiLS
Lois	90	93	Increase	IiLS
Anne	78	42	Decrease	IiPS
Elizabeth	118	120	Increase	IiPS
Helen	93	105	Increase	IiPS
Kathleen	77	70	Decrease	IiPS
Marie	91	53	Decrease	IiPS

Note. Participants were assigned pseudonyms to maintain confidentiality

Participant interviews were coded and categories were assigned to identify the potential factors that affected student acceptance of evolution over the course of the semester. The codes and categories were generated inductively as the transcripts were analyzed to align with the responses from the participants. The following factors were identified based on participant responses: *maintaining contact with parents, experiences with diversity, explicit instruction focused on evolution in the classroom and discussions with friends regarding evolution and religiousness.*

Factors that did not appear to influence student acceptance of evolution were maintaining contact with parents and experiences with diversity factors. All of the interviewed (n = 10) participants noted that they stayed in regular contact with their parents just as they had when they lived with them in high school because of communication tools such as cell phones. When asked about her contact with her parents during college, Adeline noted: "Yeah, I talked to them every single day." Then, after prompting, she compared that to how often she talked to her parents in high school and she replied: "Yeah, I talked to my parents every single day in high school too. It never changed." Additionally, most of the participants noted that they had not experienced significant differences with regards to encountering diversity (religious and ethnic) between their lives in high school and their first semesters of college. Because communication with parents and experiences with diversity did not change significantly for participants between leaving high school and entering college, I labeled them as factors that did not influence acceptance of evolution during the first semester of college.

The factors I identified as influential consisted of those factors that participants had noted as major changes between high school and college, or those they thought contributed to any changes in evolution that they perceived. The influential factors were associated with the transition to college and participants could readily recall them more often during their interviews. Participant responses highlighted the remaining factors as those that contributed to changes in their evolution acceptance. Support for those factors appears below with the excerpts from participant interviews.

Explicit Instruction Focused on Evolution in the Classroom

When asked about their exposure to evolution in the classroom during the first semester of college as well how they learned about evolution, participants responded in various ways (Table 6). A common theme among the participants, however, was that if they had sufficient classroom exposure to evolution, they increased their acceptance when compared to those participants who did not have exposure, or for which the exposure was limited and not engaging. Adeline, Anna Mae, Jane and Lois, all of whom took the life science course, increased their acceptance of evolution and were able to recall learning about evolution during the semester. In contrast, Anne, Helen and Kathleen, participants in the physical science course, had no exposure to evolution in the classroom. Therefore, classroom instruction could not explain the changes in evolution acceptance for students who did not take life science.

Table 6

Results of code "explicit instruction"

Class	Student	Quotation
IiLS	Adeline	Um, we talked a lot about it. We watched that video on Darwin, Charles Darwin, and we like talked about like how animals evolved into humans and learned like where humans came from and why they adapted and why they changed, I guess. So kind of big in life science… That video really helped, um. We did a project on it and had to write a paper and stuff. I don't know we went way into depth with it. I guess I also found it interesting so I think like the more time like, you put into it, you learn more. I guess.
IiLS	Anna Mae	During my first, semester, probably three distinct times in my science class. Um, we took an entire unit of ecology and evolution. And then actually talking even though it was just the one unit, we actually talked about it throughout DNA and all of the different cell structure and all of the different sections of the class. Even though we only had the one unit of ecology and evolution, we talked about it. It tied into everything.
IiLS	Jane	I think it was mostly just discussion. Um, he asked like people what they have learned previously and then that's about it. And like what he said... He said you could believe both, like you could still be religious but believe in the evolutionary theory. Just discussed that you don't have to be completely one-sided all the time.
IiLS	Lois	Um, only a little bit that I remember because we didn't go very much in depth with it. It was mentioned but not like for long periods of time, if that makes sense… It might have been weaved in throughout what we learned. It was kind of like mentioned but not like a whole unit all at once… Um, I think there was some sort of activity, I don't remember what it was but I remember doing a hands-on activity.

(table continues)

Class	Student	Quotation
IiLS	Danielle	First semester we talked about it, we had a unit on it. Interviewer: How long did that last? D: Maybe a couple of weeks.
IiPS	Anne	I really didn't because I didn't take any classes that would deal with evolution, so.
IiPS	Helen	I don't think it was addressed in any of my classes.
IiPS	Kathleen	I did not learn about it at all.

Discussions with Friends Regarding Evolution

Participants who discussed evolution with their friends outside of the classroom experienced changes in their acceptance of evolution, although some participants increased their acceptance, while others decreased their acceptance (Table 7). Anne decreased her acceptance of evolution and noted that she debated with her friends regarding evolution over the course of the semester. When asked about what may have influenced her acceptance, Anne indicated that the increased exposure to evolution outside the classroom could have contributed to her changes in acceptance. Anna Mae provided a contrasting response regarding the impact of her conversations with friends over the course of the semester. Although her score did not reflect a change in acceptance, Anna Mae indicated that she had become more accepting of evolution over the course of the semester, and identified her friends as a potential influence. Helen also noted a discussion she had with a friend outside of the classroom in which evolution was the topic, and it may have influenced her acceptance of evolution without recognizing it.

Table 7

Results of code "discussions with friends"

Class	Student	Quotation
IiPS	Helen	I actually did have a conversation about it with a friend of mine who I met through a religious thing. We just kind of talked about different opinions on it, but it was maybe an hour-long conversation.
IiPS	Anne	My friends and I like to talk about religion and evolution to contrast and compare, and, I don't know we just talked about it briefly. Share what we know and debate a little...maybe being exposed to the idea more would have caused any slight changes. It probably decreased because I've been more exposed to evolution and have actually become more rejecting.
IiLS	Anna Mae	But definitely my friends talk about it all the time and how their viewpoints have changed. He talks about it all the time how its changed and he's so into science and all the time, always talking about evolution. So I know that friend of mine talks about it all the time and how his views of changed from the beginning of the semester to now…My friend I talked about earlier, he talks about it all the time and then just seeing how he's even changed who at one point was a die-hard Christian to now being pretty sure he's an atheist. Seeing that change just made me lean more toward evolution

Religiousness

Religion was another factor mentioned by many participants and it appeared to be highly influential in changing a participant's acceptance of evolution (Table 8). When asked how often they participated in religious activities (e.g., going to church, participating in religious church groups, discussions) in comparison to high school, participants provided varying responses that likely affected their acceptance.

Table 8

Results of code "religiousness"

Class	Student	Quotation
IiLS	Jane	I probably only went like twice to church and that was when I was back home. I didn't attend church on campus. I like don't not believe in it [evolution], it makes more sense to me really than like the religious version, and...so like yeah, no not really. I've always believed it could be true, so not really.
IiLS	Anna Mae	I didn't. I feel like I went to something once, but I can't think of what it was so I'm just going to say I didn't. In high school I went to Sunday church every once in a while and I went to a regular Wednesday youth group all the time. Even then, I was still kind of like, I'm here, we will see how it goes but I don't know what I believe in and think. Here, I haven't gotten into anything mostly because of time but because I have learned a lot more and I don't have to focus on that one trail of being.
IiLS	Adeline	A: Probably every other week, like twice a month I guess. I didn't go to church in high school, so its kinda like I go to church more now than I used to. I go on Thursday nights now and I didn't do anything in high school. Interviewer: Do you think your acceptance of evolution changed? If so, what may have contributed to it? A: I guess I knew the concept and everything, but like, and I guess going to church more, and I don't know, church and evolution are like. The Bible and evolution are kinda like controversial. I understand and like, I don't know it's kind of hard to wrap my head around what is happening in both aspects. I don't know, it is kind of like what you think and how you interpret it.

(table continues)

Class	Student	Quotation
IiPS	Marie	A: I went to like church Sunday morning and then I'm in The River which is Sunday night and then, I have two Bible studies and then Wednesday night I help out with middle school. Then on Thursday nights I have church too. So basically everyday but Tuesday and Friday I do something related to church. I: Do you think your acceptance of evolution changed? If so, what may have contributed to it? A: I think I am pretty strong in what I believe and so yeah, I don't think so. It's been interesting to think like well yeah that would make sense why that would be, but I think that just from where I come from and like what I believe is that evolution is conflicting. It's a little confusing in that aspect so, yeah. I'm more involved in Basic and in the River and have learned more about my own faith and those views are conflicting.
IiLS	Danielle	D: I've been participating a lot more. In high school I went once a week and now I go three times, so it's more. I: Do you think your acceptance of evolution changed? If so, what may have contributed to it? D: Decreased. Probably just like a combination of getting all of the information because you get information from church and that is completely different from what you get in the classroom so it is like finding a medium in what you believe.

For those participants who became more accepting, some became less religious over the course of the semester. Anna Mae, for example, noted that she stopped participating in religious activities, which contrasted to her participation in high school.

Jane also decreased her religious participation over the course of the semester and it contributed to her increased acceptance of evolution. When asked what contributed to a change, she noted that evolution made more sense than the religious version.

For those who increased their religiousness, the participants learned about evolution within the context of their religion in a more opportunistic manner in which they had a choice in what they would accept. Adeline experienced an increase in religiousness while also becoming more accepting of evolution. When asked what contributed to her increased acceptance of evolution, Adeline noted that she received information regarding the controversy between evolution and religion but noted that she had to decide to interpret the information in ways that made sense to her. Rather than accepting everything she learned in church, Adeline decided it was up to her to decide her views on evolution.

In contrast, the participants who decreased their acceptance over the semester were also those who became more actively involved in religion or maintained their level of involvement as they had in high school. They also received clear messages indicating the perceived dichotomy between evolution and religion. Marie became less accepting of evolution and attributed her decreased acceptance to becoming more involved in her own faith. Danielle also became more involved in religious activities over the course of the semester, while becoming less accepting of evolution because she received conflicting information in church regarding evolution compared to what she learned in the classroom.

Explicit instruction in the classroom, conversations with friends and changes in religious participation influenced student acceptance of evolution for participants during their first semesters of college. The factors tended to affect participants differently depending on each individual. For most participants, explicit instruction was often

associated with increased acceptance. Discussions with friends led to decreased acceptance for some participants while it led to increased acceptance for others. Increased participation in religion was often associated with a decrease in acceptance of evolution for most participants, while a decrease in religious participation was associated with an increase in acceptance.

CHAPTER 5

DISCUSSION

The current study explored how first-year experiences in higher education influenced student acceptance of evolutionary theory and identified those experiences that were associated with changes in student acceptance of evolution. A comparison of the pre-survey and post-survey scores on the I-SEA provides evidence that various first-year experiences in college did influence student acceptance of evolution. After speaking with participants who experienced changes, the factors that were most influential in affecting student acceptance were: explicit instruction on evolution in the classroom, discussions with friends centered on evolution and religious involvement.

Although the three factors mentioned previously were the most influential in changing student acceptance of evolution, they did not lead to strong knowledge restructuring, otherwise known as conceptual change. Within the context of the current study, participants who experienced conceptual change would be able to recognize the separation of religion and evolution with regards to what they explain about the world, and also be able to accurately recall what evolution is. Instead, most of the participants who experienced change appeared to assimilate the information they received on evolution. Rather than separating religion and evolution and knowing the core tenets of evolution, participants who assimilated the information restructured what they were learning about evolution so that it fit within their previous religious beliefs and prior knowledge of evolution. For most participants, this involved including religion and evolution in a continuum, instead of recognizing them as separate and different.

Research Question 1

The first research question asked, "How do college students' first-year experiences influence their acceptance of evolution?" The first-year experiences of college students affected their acceptance of evolution in various ways. Nineteen students increased their acceptance of evolution, whereas nine students decreased their acceptance. Two of the students did not change their acceptance of evolution as measured by the I-SEA. Ten students in IiLS increased their acceptance of evolution compared to 9 students who increased their acceptance in IiPS.

Based on the direct exposure to evolution in the classroom, I assumed that students in IiLS would become more accepting of evolution because of the opportunities to confront their misconceptions and thus, experience conceptual change. Conversely, students in IiPS should have been less likely to experience changes in their acceptance of evolution because of the limited exposure to evolution in the classroom. The results revealed, however, that the changes in acceptance for both populations included a wide range of variance. The variance can be attributed to the outliers in the decreases in acceptance for both populations. Additionally, the t-test revealed that the changes in acceptance for both groups were not significantly different. Students in both IiLS and IiPS experienced similar levels of increase in their acceptance, which indicates that other factors besides formal instruction were influential in affecting acceptance of evolution.

Although some students in both courses decreased their acceptance, students in IiPS decreased their acceptance by a wider range of scores compared to the students who decreased their acceptance in IiLS. The students in IiPS experienced changes that ranged

in a decrease of acceptance by 38 to an increased acceptance of up to 17. Three of the students in IiPS decreased their acceptance by scores of 30, 36 and 38. The variance in those changes could not be attributed to formal evolution instruction, which means that other outside factors were influential for the students in IiPS.

The mean scores for the pre and post-test measures of acceptance for both classes revealed that the students in IiLS started at a higher level of acceptance compared to those in IiPS, which means that the populations were not the same at the start of the study. Additionally, the students in IiLS did not change their acceptance by a notable amount in contrast to the students in IiPS who decreased their acceptance by a mean score of 4. The outside factors that influenced students in IiPS should have also been salient for the participants in IiLS because those students were also transitioning to college during the semester, so something must have mitigated the potential changes in acceptance for students in IiLS.

It might be possible that the evolution instruction that IiLS students received, in combination with other outside factors, may have influenced them enough to begin assimilating information, but it did not result in overall drastic changes in acceptance. In contrast, the lack of classroom exposure may have influenced IiPS students to resist or reject new information, rather than restructure their knowledge, which may explain the average decrease in acceptance for those students. Students in IiLS had more opportunities to engage with the new information in ways that would promote conceptual change because they learned the content from teachers who could confront misconceptions and provide opportunities for students to alter prior knowledge. In

contrast, students in IiPS learned about evolution in other informal ways that may not have provided as many opportunities for conceptual change to occur, leading those who did not accept evolution to become even less accepting after learning additional information.

Research Question 2

Assuming that student acceptance of evolution would change over the course of 16 weeks, the second research question asked, "What first-year experiences influence changes in student acceptance of evolution?" I utilized participant interviews to answer the second research question in order to determine why acceptance of evolution changed in the different directions. The interviews revealed that discussions with friends (often within the context of religion), classroom instruction on evolution, and religious involvement over the course of the semester were instrumental in inducing changes in student acceptance of evolution. For most students, regular religious involvement in the absence of classroom exposure to evolution was associated with a decrease in acceptance based on the pre- and post-scores of the I-SEA. For those who became more accepting of evolution, either a decrease in religiousness or increase in religiousness occurred. The difference, however, is that when religiousness increased, students had exposure to evolution in the classroom at the same time or they had discussions with friends in which evolution was not debated in contrast to religion. Thus, students were influenced by other factors besides the increase in religiousness, rather than the increase in religiousness serving as the only influential factor of evolution acceptance.

Decreased Acceptance of Evolution

Three of the students who decreased their acceptance inferred that there was a dichotomy between accepting evolution and maintaining religious beliefs. Anne (IiPS) had discussions with friends, in which they compared and contrasted evolution and religion, demonstrating that they view evolution and religion as two separate, contrasting concepts. She noted that she became less accepting because she learned more about evolution through her increased religious involvement and talking with friends. Similarly, Marie (IiPS) learned about evolution within the context of her religious involvement and she learned that the facts of evolution conflicted with her religious beliefs. Kathleen (IiPS) also maintained her strong religious beliefs and noted that she believed in God and that He created everything, so evolution cannot be correct. All three of these students appeared to reject evolution so that they could accept what they believed religiously, placing them on the religious end of the continuum.

Danielle (IiLS) decreased her acceptance of evolution but her experiences were different from the previous three students because she had some limited exposure to evolution in the classroom. Instead of rejecting the possibility of evolution, Danielle noted that she learned that it was more about finding a medium in what she believed. From her view, one chooses within a continuum between religion and evolution, in which both evolution and religion cannot receive acceptance simultaneously.

Increased Acceptance of Evolution

Six of the interviewed students increased their acceptance of evolution over the course of the semester. Two of those students, Elizabeth (IiPS) and Lois (IiLS),

experienced slight increases in which they could not identify a salient determining factor. It is possible that their increases on the I-SEA occurred because they answered one question differently on the post-test compared to the pre-test, but the changes were not actually due to first-year experiences. The other four students experienced increases in acceptance in which religion, classroom exposure, and discussions with friends became influential.

Helen (IiPS) and Adeline (IiLS) both recalled increased religious involvement over the course of the semester, but increased their acceptance of evolution. Helen did not have exposure to evolution in the classroom, so her discussions regarding evolution were limited to those she had with friends. She recalled an hour-long conversation with a friend in which they discussed evolution and different opinions on it. In contrast to those who decreased their acceptance, it seemed as though Helen's discussion with her friend did not include a discussion of both evolution and religion within the same context. She was able to discuss evolution in a less controversial manner. Instead of rejecting evolution for her religious beliefs, Helen was able to assimilate the new information regarding evolution into her previous beliefs, leading to weak knowledge restructuring.

Like Helen, Adeline also became more involved in religious activities her first semester of college. Adeline learned through church that her religious beliefs and evolution are controversial and that they conflict. However, she did not reject evolution outright based on what she learned in church; instead, Adeline noted that what she would accept was based on her own interpretation. She also mentioned that learning about evolution in class was engaging and that she could see both sides of religion and

evolution and she could interpret it differently. Similarly to Helen, Adeline began to assimilate, rather than reject, what she was learning about evolution into her existing ideas, which may have contributed to her increased acceptance of evolution.

Anna Mae (IiLS) and Jane (IiLS) both became more accepting of evolution in combination with a decrease in religiousness, classroom exposure to evolution and for Anna Mae, discussions with friends. As mentioned previously, Anna Mae's score did not change from pre-survey to post-survey, but her interview revealed that she thought she had increased her acceptance over the course of the semester regardless of her score. She explained that her new friends, who had taken biology classes over the course of the semester, were highly influential in changing what she had previously thought about evolution. She also learned about evolution in her class over the course of the semester because it was tied into everything they learned rather than learning about evolution in isolation.

Anna Mae also made the decision to not attend church as she had in high school, a decision that her friends also helped her to make because of their decrease in religiousness. Although Anna Mae increased her acceptance and was less involved in religion, her responses during the interview revealed that she still viewed evolution and religion on a continuum rather than two separate entities that explained different things. She mentioned that she decreased in her religiousness and learned about evolution in class and because of those, she leaned more toward evolution instead of religion. Rather than accommodating what she learned about evolution, and realizing that evolution and

religion do not have to be viewed as two ends of the spectrum, Anna Mae assimilated the new information so that the choice became either religion or evolution.

Similarly, Jane was less involved in religious activities and learned about evolution in the classroom. Although learning about evolution in the classroom influenced Jane, she learned about it in a more distinct period of time rather than learning about it throughout the class as Anna Mae had. Regardless, for Jane, evolution made more sense than the religious version of explanations, and she chose to accept evolution because of it. Again, Jane viewed evolution and religion on a continuum in which a person should choose one view over the other. Instead of rejecting what she learned, Jane assimilated the information regarding evolution into her previous knowledge.

Barriers to Conceptual Change

Theoretically, the participants in this study should have undergone conceptual change in which they altered their preconceptions for new information they were learning about evolution over the course of the semester. The researcher predicted that participants would experience cognitive conflict resulting in disequilibrium between what they previously knew and what they learned about evolution throughout the semester. Based on the disequilibrium, students would alter their preconceptions and accept the new information by strongly restructuring their existing knowledge. The discussions regarding evolution with friends, instruction on evolution, and religious participation all provided opportunities for disequilibrium in which the participants could learn about evolution and make changes to what they previously understood. Instead of experiencing conceptual change, or accommodation, most of the participants appeared to undergo

assimilation in which they made the new information fit within what they already knew, rather than changing their preconceptions. Why did participants assimilate the information rather than accommodate it as predicted?

According to Limon (2001), cognitive conflict is a necessary first step for people when achieving conceptual change. The novel information (in this study, evolutionary facts) leads people to feel dissatisfied between what they thought they knew and the new information. The dissatisfaction causes students to reorganize, restructure or change their existing ideas regarding the information. However, it appears as though participants in the current study underwent assimilation rather than accommodation. Assimilation is in contrast to accommodation because assimilation is a form of weak knowledge restructuring rather than the radical knowledge restructuring required of accommodation (Duit & Treagust, 2003). Direct assimilation involves fitting new information into previous knowledge or schemas or people can exclude the new information if it does not fit within previous knowledge. People will ignore the new information or distort it so that will fit within the preconceptions (Limon, 2001).

The participants who increased their acceptance seemed to restructure evolution within what they previously knew because they still viewed evolution and religion on a continuum. Similarly, the participants who decreased their acceptance assimilated the new information and they chose to view evolution and religion as a dichotomy in which they rejected the information in favor of previous beliefs. Thus, the participants who decreased their acceptance chose to pick the religious side of the continuum in contrast to those who became more accepting and fell more on the evolution side.

One of the possible explanations for the lack of conceptual change in this study is that the new information did not induce cognitive conflict in the participants. Instead, the new information only urged participants to fit the new information into what they previously knew without creating conflict. In order to induce change, the conflict needs to be viewed as meaningful (Limon, 2001). Some of the participants may not have viewed evolution as a meaningful conflict in contrast to their religion and chose to reject it instead, which resulted in decreased acceptance. If previous knowledge is deeply entrenched in someone's mind, it can affect how he or she reacts to novel information (Limon, 2001). As Wiles and Alters (2011) noted, people can hold the false belief that their religion directly conflicts with evolution, a situation in which they are more likely to abandon evolution in favor of their religious beliefs. As the current study demonstrates, these false beliefs are robust and are less likely to be altered in light of new information. Everyday experiences, such as learning in the classroom, are not likely to change previously held beliefs (Chi, 2008). This could explain why increased religiousness became an influential factor for those who decreased their acceptance of evolution.

The participants, who assimilated the facts of evolution into their existing knowledge by forming a continuum between religion and evolution, also became more accepting of evolution in the process. One reason they may have assimilated the information rather than undergoing conceptual change is because conceptual change is often a more gradual process. Radical knowledge restructuring is harder to achieve and requires more time than is provided when briefly introducing new information (Limon, 2001). Most of the participants acknowledged that they had limited to no exposure to evolution in high

school and because of the limited exposure, the students in IiLS may have required more than a unit's time to undergo the radical change necessary for accommodation. Additionally, students in IiPS may have needed more than a couple of brief conversations regarding evolution to experience accommodation. According to Limon (2001), limited previous knowledge on a topic makes it more difficult to expect conceptual change because the lack of understanding does not provide an opportunity for meaningful conflict. Thus, it appears that the changes in evolution acceptance in the current study are best explained by the process of assimilation through either weak restructuring of knowledge or the exclusion of new information that does not fit within a pre-existing network of knowledge. The influential factors during the first semester of college that initiated the assimilation process consisted of evolution instruction, discussions with friends and religion.

Limitations

Although student acceptance of evolution changed in the current study, there are limits to which the findings can be generalized to a larger population. The participants in the study majored in elementary education or had the intention of majoring in elementary education, decreasing the generalization to people in other professions outside of elementary education. Of the participants interviewed, there was a shared consensus in that they all lacked previous exposure to evolution when starting college and the limited exposure could have been responsible for the higher rates of assimilation rather than accommodation. It may be possible that if students were more familiar with evolution, the presented information would have invoked more radical restructuring because of

meaningful conflicts. Although gender was not a variable of focus, all ten of the interviewees were female, limiting the generalizability of the findings to the male population. In addition, the participants were all recruited from a mid-sized university in the Midwest, which may affect how the conclusions extend to students in different education settings in different regions of the nation and internationally.

There were also unforeseen problems associated with using the I-SEA as a measure of student acceptance of evolution. The I-SEA does not provide a scoring guide to which acceptance is clearly indicated so slight increases or decreases in points may not actually be valid changes in acceptance. Instead, the changes in evolution that occurred may have been artificial because of the Likert-like testing completed in different months. Most of the participants demonstrated a higher level of acceptance initially, which may have resulted in the difficulty of detecting drastic changes in acceptance. For example, some participants appeared to change their acceptance more dramatically than as detected by the I-SEA. The interview with Anna Mae revealed a self-reported increased acceptance of evolution, but her score (95) did not change between the pre-survey and post-survey. Because of the lack of guidance in scoring, it became difficult to compare someone with a slight increase in acceptance versus someone with a larger increase in scores over the course of the semester.

Future research involving first-year experiences may benefit from interviews of males as well as utilizing other inventories of student acceptance of evolution to increase validity. Regardless of the limitations, changes in student acceptance of evolution occurred over the course of the semester and factors were identified that could have

contributed to those changes. These factors may be important sources of information for those who teach evolution to students.

Implications

The results of the current study provide implications for science educators, particularly those who teach evolution. Teachers who espouse the cognitive constructivist theory when teaching are more likely to expect that their students will undergo conceptual change if they identify student misconceptions and then provide experiences that are contradictory to those misconceptions to allow opportunities for knowledge restructuring (Limon, 2001). Novel information that appears to provide a meaningful conflict or is contradictory to previous knowledge may not actually be a meaningful conflict to students.

As this study demonstrates, in situations where meaningful conflict is not reached or students do not view information as contradictory, students will assimilate the new information and strengthen their previous beliefs even if it means aligning themselves on a different end of the spectrum. In the case of students assimilating the information, meaningful learning will not actually occur because accommodation has not happened. In addition, because conceptual change is gradual, it may require that teachers incorporate evolution in every unit of a biology course rather than teaching it in isolation from the rest of the material. Additionally, students may need repeated exposure to evolution throughout their education for conceptual change to result. The repeated exposure to the content could result in additional opportunities in which students can

experience conflict and thus, restructure their prior knowledge to result in meaningful learning.

When teaching evolution, teachers should be clear that evolution and religion are not incompatible. Instead, they need to be viewed as separate notions that explain different things about the world. If teachers approach evolution in this way, it may be more likely that students will at least begin the process of accommodation rather than completely rejecting the new information regarding evolution. Teachers should also be aware that students might be learning conflicting information regarding evolution outside of the classroom in religious situations and also when students are having discussions with friends. These different factors can greatly influence how a student interprets new information and can affect whether or not conceptual change, and thus, meaningful learning occurs.

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APPENDIX A

PRE-SURVEY: FALL 2014

Please write your middle name and the last four digits of one of your parent's phone numbers here. This will be used to pair your surveys from the beginning of the semester and the end of the semester. Please remember the phrase you provide so that you can indicate the same phrase at the end of the semester.

Which inquiry into science class are you currently enrolled? Please check all that apply:

- Inquiry into Life Science
- Inquiry into Physical Science
- Inquiry into Earth Science

What year did you graduate from high school? _____

What is your major or intended major:

_____

Number of high school science courses before enrollment in this course: _____

For the following items, please indicate your agreement/disagreement with the given statements using the following scale:

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1. I think that new species *evolved* from ancestral species.					
2. I think that the fossil evidence that scientists use to support evolutionary theory is weak and inconclusive.*					
3. There are a large number of fossils found all around the world that support the idea that organisms *evolve into new species over time.*					
4. I think all complex organisms evolved from single celled organisms.					
5. I think that new species evolve from a lot of small changes occurring over relatively long periods of time.					
6. There is little or no observable evidence to support the theory that describes how one species of organism evolves from *a different* ancestral form.*					
7. The forms and diversity of organisms have changed dramatically over time.					
8. I think that all organisms are related (or share a common ancestor).					
9. I think that organisms, as they exist now, are perfectly adapted to their natural environments and so will not continue to change.*					
10. All groups of organisms will continue to change.					

*Indicates reverse item

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
11. There are a large number of examples of organisms that have undergone evolutionary *changes within the species* (i.e., antibiotic resistance in bacteria, production of new strains of the flu virus).					
12. Species were created to be perfectly suited to their environment, so they do not change.*					
13. I don't accept the idea that a species of organism will evolve new traits over time.*					
14. I think there is an abundance of observable evidence to support the theory describing how *variations within* a species can *happen.*					
15. *Species* exist today in exactly the same *shape and* form in which they always have.*					
16. There is overwhelming evidence supporting the theory of evolution to explain how *variations in* a species *develop* over time.					
17. There is reliable evidence to support the theory that describes how humans were derived from ancestral primates.					
18. Although humans may adapt, humans have not/do not evolve.					
19. I think that the physical structures of humans are too complex to have evolved.*					
20. I think that humans and apes share an ancient ancestor.					
21. I think that humans evolve.					
22. Humans do not evolve; they can only change their behavior.*					
23. The many characteristics that humans share with other primates (i.e., chimpanzees, gorillas) can best be explained by our sharing a common ancestor.					
24. Physical variations in humans (i.e., eye color, skin color) were derived from the same processes that produce variation in other groups of organisms.					

* Indicates reverse item

APPENDIX B

POST-SURVEY: FALL 2014

Please write your middle name and the last four digits of one of your parent's phone numbers here. Please use the same phrase that you used when you completed this survey at the beginning of the semester.

Which inquiry into science class are you currently enrolled? Please check all that apply:

- Inquiry into Life Science
- Inquiry into Physical Science
- Inquiry into Earth Science

What year did you graduate from high school? _____

What is your major or intended major:

_____

Number of high school science courses before enrollment in this course: _____

For the following items, please indicate your agreement/disagreement with the given statements using the following scale:

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1. I think that new species *evolved* from ancestral species.					
2. I think that the fossil evidence that scientists use to support evolutionary theory is weak and inconclusive.*					
3. There are a large number of fossils found all around the world that support the idea that organisms *evolve into new species over time.*					
4. I think all complex organisms evolved from single celled organisms.					
5. I think that new species evolve from a lot of small changes occurring over relatively long periods of time.					
6. There is little or no observable evidence to support the theory that describes how one species of organism evolves from *a different* ancestral form.*					
7. The forms and diversity of organisms have changed dramatically over time.					
8. I think that all organisms are related (or share a common ancestor).					
9. I think that organisms, as they exist now, are perfectly adapted to their natural environments and so will not continue to change.*					
10. All groups of organisms will continue to change.					

*Indicates reverse item

	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
11. There are a large number of examples of organisms that have undergone evolutionary *changes within the species* (i.e., antibiotic resistance in bacteria, production of new strains of the flu virus).					
12. Species were created to be perfectly suited to their environment, so they do not change.*					
13. I don't accept the idea that a species of organism will evolve new traits over time.*					
14. I think there is an abundance of observable evidence to support the theory describing how *variations within* a species can *happen.*					
15. *Species* exist today in exactly the same *shape and* form in which they always have.*					
16. There is overwhelming evidence supporting the theory of evolution to explain how *variations in* a species *develop* over time.					
17. There is reliable evidence to support the theory that describes how humans were derived from ancestral primates.					
18. Although humans may adapt, humans have not/do not evolve.					
19. I think that the physical structures of humans are too complex to have evolved.*					
20. I think that humans and apes share an ancient ancestor.					
21. I think that humans evolve.					
22. Humans do not evolve; they can only change their behavior.*					
23. The many characteristics that humans share with other primates (i.e., chimpanzees, gorillas) can best be explained by our sharing a common ancestor.					
24. Physical variations in humans (i.e., eye color, skin color) were derived from the same processes that produce variation in other groups of organisms.					

*Indicates reverse item

1. Please list some activities you participated in during your first semester of college:

2. How difficult was it to make friends during your first semester of college?

3. Do you feel that you have “settled in” to college? Please explain.

4. How often did you go home during your first semester of college?

5. How connected do you feel to campus live compared to your home life?

6. What was the most difficult part of transitioning to college?

Please provide an email address that you can be reached at if you would like to be considered for a follow-up interview. Participants who are chosen for the follow-up interview during the Spring 2015 semester will receive a $50 Amazon gift card.

_____

APPENDIX C

INTERVIEW QUESTIONS AND SCRIPT: SPRING 2015

1. On average, how often did you learn about evolution in the classroom during your first semester of college? How does this compare to the time you spent learning about evolution in high school?

2. What types of activities did your science teachers use to explain evolution to your class during this semester? How does this compare to the activities your science teachers used in high school?

3. How much time would you estimate you spent discussing evolution with your parents, friends, or hearing about evolution within the media, during your first semester of college (outside of the classroom)? How does this compare to the time you spent in high school?

4. How often did you speak with your parents during your first semester of college? How does this compare to how often you spoke with your parents in high school?

5. How many times per month did you participate in religious activities (e.g., attending church, participating in church groups, church discussions) during your first semester of college? How does this compare to how often you participated in religious activities in high school?

6. Why did you choose to participate in religious activities during your first semester of college? Why did you choose to participate in religious activities in high school?

7. How much diversity (e.g., cultural, ethnic, religious) did you encounter during your first semester of college? How does this compare to your experience with diversity in high school?

8. Do you think that you have changed your views regarding evolution from the beginning of this semester? What do you feel may have contributed to this change?

APPENDIX D

IRB APPROVAL LETTER

Office of Research and Sponsored Programs

University of Northern Iowa

Human Participants Review Committee
UNI Institutional Review Board (IRB)
213 East Bartlett

Lauren Scherff
207 Brentwood Drive, #1
Cedar Falls, IA 50613

Re: IRB 15-0003

Dear Ms. Scherff:

Your study, **Exploring How First-year Experiences in Higher Education Influence Student Acceptance of Biological Evolutionary Theory** has been approved by the UNI IRB effective **7/23/14**, following an Expedited review of your application performed by **IRB member, Helen Harton Ph.D.** You may begin enrolling participants in your study.

Modifications: If you need to make changes to your study procedures, samples, or sites, you must request approval of the change before continuing with the research. Changes requiring approval are those that may increase the social, emotional, physical, legal, or privacy risks to participants. Your request may be sent to me by mail or email.

Problems and Adverse Events: If during the study you observe any problems or events pertaining to participation in your study that are *serious* and *unexpected* (e.g., you did not include them in your IRB materials as a potential risk), you must report this to the IRB within 10 days. Examples include unexpected injury or emotional stress, missteps in the consent documentation, or breaches of confidentiality. You may send this information to me by mail or email.

Expiration Date: Your study **approval will expire on 7/23/15** Beyond that, you may not recruit participants or collect data without continuing approval. We will email you an Annual Renewal/Update form about 4-6 weeks before your expiration date, or you can download it from our website. You are responsible for seeking continuing approval before your expiration date *whether you receive a reminder or not.* If your approval lapses, you will need to submit a new application for review.

Closure: If you complete your project before the expiration date, or it ends for other reasons, please download and submit the IRB Project Renewal/Closure form and submit in order to close our your protocol file. It is especially important to do this if you are a student and planning to leave campus at the end of the academic year. Advisors are encouraged to monitor that this occurs.

Forms: Information and all IRB forms are available online at http://www.uni.edu/rsp/protection-human-research-participants.

If you have any questions about Human Participants Review policies or procedures, please contact me at 319.273.6148 or anita.gordon@uni.edu. Best wishes for your project success.

Sincerely,

Anita M. Gordon

Anita M. Gordon, Ph.D.
IRB Administrator

cc: John Ophus, Faculty Advisor

213 East Bartlett Hall • Cedar Falls, Iowa 50614-0394 • Phone: 319-273-3217 • Fax: 319-273-2634 • E-mail:rsp@uni.edu • Web: www.uni.edu/rsp

APPENDIX E

PRE- AND POST- TEST CONSENT FORM

UNIVERSITY OF NORTHERN IOWA
HUMAN PARTICIPANTS REVIEW
INFORMED CONSENT

Project Title: Exploring How First-year Experiences in Higher Education Influence Student Acceptance of Biological Evolutionary Theory

Name of Investigator(s): Lauren Winter

Invitation to Participate: You are invited to participate in a research project conducted through the University of Northern Iowa. The University requires that you give your signed agreement to participate in this project. The following information is provided to help you made an informed decision about whether or not to participate.

Nature and Purpose: This study is designed to identify different factors that may affect student acceptance of evolutionary theory.

Explanation of Procedures: If consent is given to participate, participants will be asked to complete a brief demographic survey as well as a 33-item questionnaire that includes different statements regarding evolutionary theory at the beginning of the Fall 2014 semester during regularly scheduled class time. Participants will be asked to complete this questionnaire and an additional survey a second time at the end of the Fall 2014 semester.

Participants will not miss any regularly scheduled class and participation will not affect the participant's final grade in the course. If you choose not to participate, you will be given an alternative activity to complete while participants complete the questionnaires.

The purpose of the questionnaire is to determine the participant's initial and final measure of acceptance of evolution. An individual unaffiliated with your class may contact you by email to participate in an audiotaped interview after the final survey has been completed (in the first half of the Spring 2015 semester). The purpose of the interview is to provide additional information to support responses to the questionnaire and will include questions that ask about different experiences during the first semester of college. The interview is essential to highlight the factors that may affect participant acceptance of evolution.

All data collection will take place on the campus of the University of Northern Iowa. All data and accompanying information will be destroyed at the end of the study.

Discomfort and Risks: Risks to participation are similar to those experienced in day-to-day life. Participants may feel slight discomfort when discussing evolutionary theory or explaining experiences during the first semester of college during the audiotaped interview.

Benefits and Compensation. There is no direct benefit for participant participation. Compensation in the form of a $50 Amazon gift card will be given for participants who are chosen to participate in the interviews. Results from the research may benefit the field of study and ensure best practices for teaching students about evolutionary theory in a way that will further benefit students.

Confidentiality: Information obtained during this study, which could identify you, will be kept confidential. The summarized findings with no identifying information may be published in an academic journal or presented at a scholarly conference.

Right to Refuse or Withdraw: Your participation is completely voluntary. You are free to withdraw from participation at any time or to choose not to participate at all, and by doing so you will not be penalized.

Questions: If you have questions about the study or desire information in the future regarding your participation or the study generally, you can contact Lauren Winter at 515-571-3992 or the project investigator's faculty advisor John Ophus at the Department of Biology, University of Northern Iowa, at 319-273-3960. You can also contact the office of the IRB Administrator, University of Northern Iowa, at 319-273-6148, for answers to questions about rights of research participants and the participant review process.

Agreement:

> **I am fully aware of the nature and extent of my participation in this project as stated above and the possible risks arising from it. I hereby agree to participate in this project. I acknowledge that I have received a copy of this consent statement. I am 18 years of age or older.**

_____ _____

(Signature of participant) (Date)

_____

(Printed name of participant)

(Signature of investigator)	(Date)
(Signature of instructor/advisor)	(Date)

APPENDIX F

INTERVIEW CONSENT FORM

UNIVERSITY OF NORTHERN IOWA
HUMAN PARTICIPANTS REVIEW
INFORMED CONSENT

Project Title: Exploring How First-year Experiences in Higher Education Influence Student Acceptance of Biological Evolutionary Theory

Name of Investigator(s): Lauren Winter

Invitation to Participate: You are invited to participate in a research project conducted through the University of Northern Iowa. The University requires that you give your signed agreement to participate in this project. The following information is provided to help you made an informed decision about whether or not to participate.

Nature and Purpose: This study is designed to identify different factors that may affect student acceptance of evolutionary theory.

Explanation of Procedures: If consent is given to participate, participants will be asked to participate in an audio taped interview that will last approximately 20-30 minutes. The purpose of the interview is to provide additional information to support responses to I-SEA questionnaire that you completed previously, and will include questions that ask about different experiences during the first semester of college. The interview is essential to highlight the factors that may affect participant acceptance of evolution. Participant responses from the audio taped interview will be transcribed. Direct quotes from participants may be used in a final paper to support the author's conclusions, but the quotes will not reveal a participant's identity.

All data collection will take place on the campus of the University of Northern Iowa. All data and accompanying information will be destroyed at the end of the study.

Discomfort and Risks: Risks to participation are similar to those experienced in day-to-day life. Participants may feel slight discomfort when discussing evolutionary theory or explaining experiences during the first semester of college during the audio taped interview.

Benefits and Compensation. There is no direct benefit for participant participation. Results from the research may benefit the field of study and ensure best practices for teaching students about evolutionary theory in a way that will further benefit students.

Compensation in the form of a $50 Amazon gift card will be given for participants who are chosen to participate in the interviews. Names, contact information, and student ID numbers for participants receiving compensation must be provided to the University of Northern Iowa Office of Business Operations (OBO). Participants may be required to complete a tax form from the University of Northern Iowa at the end of the academic year, per IRS requirements. Data directly related to the research will not be provided to the OBO. The OBO has careful procedures in place to keep identifying information confidential and participants may choose not to receive payments if they prefer not to have their identifying information provided to anyone outside the research team.

Confidentiality: Information obtained during this study, which could identify you, will be kept confidential. All audio taped interviews will be kept on a password-protected computer and will be destroyed at the completion of the study. Transcriptions from the interviews will be kept but all participant names will be replaced with pseudonyms. Quotes used in the findings will be identified using the assigned pseudonyms. The summarized findings with no identifying information may be published in an academic journal or presented at a scholarly conference.
Right to Refuse or Withdraw: Your participation is completely voluntary. You are free to withdraw from participation at any time or to choose not to participate at all, and by doing so you will not be penalized.

Questions: If you have questions about the study or desire information in the future regarding your participation or the study generally, you can contact Lauren Winter at 515-571-3992 or the project investigator's faculty advisor John Ophus at the Department of Biology, University of Northern Iowa at 319-273-3960. You can also contact the office of the IRB Administrator, University of Northern Iowa, at 319-273-6148, for answers to questions about rights of research participants and the participant review process.

Agreement:

> **I am fully aware of the nature and extent of my participation in this project as stated above and the possible risks arising from it. I hereby agree to participate in this project. I acknowledge that I have received a copy of this consent statement. I am 18 years of age or older.**

_____ _____

(Signature of participant) (Date)

_____

(Printed name of participant)

_____ _____

(Signature of investigator) (Date)

_____ _____

(Signature of instructor/advisor) (Date)