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Academic Factors that Predict Community College Students' Acceptance of Evolution

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DEDICATION

I dedicate this dissertation to my devoted grandmother and grandfather, Violet and Herbert Dorner. Through their love and support, I was encouraged to reach for the stars, go after my dreams, and always remember that the sun will come out tomorrow.

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ABSTRACT

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by Meredith Anne Dorner

There is great disagreement in the United States about with how evolution education should be dealt, as the acceptance of evolution is controversial among the general public of the United States. Furthermore, although a plethora of research has been conducted to understand which factors influence the understanding and acceptance of evolution among high school and university students -- and the general public -- there are few studies focusing on community college students. In an effort to help fill this gap in the literature, this dissertation investigates the relationship between the acceptance of evolution and academic factors among community college students. Specifically, 867 community college students were surveyed using aspects of validated instruments regarding their attitudes towards evolution and human evolution, understanding of evolution and the nature of science, previous science experience, career goals, and demographic information. The results indicated that the community college students accepted evolution at a higher level than the general public and they accepted human evolution relatively less than evolution in general. Acceptance of evolution and human evolution were highly correlated, and regression analysis revealed they were the best predictors for each other after controlling for all of the factors measured. Understanding of evolution and the nature of science were also highly correlated with the acceptance of evolution and moderately correlated with the acceptance of human evolution. The data

also indicate that these community college students did not have a solid understanding of evolution. These findings have implications for the teaching of evolution as they serve to reinforce the importance of understanding both evolution and the nature of science and their relationship to the acceptance of evolution.

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Chapter 1: Introduction

In this chapter, I describe the problem of the acceptance of evolution in science education. I outline the purpose of this study and discuss the importance of this work. After explaining the guiding research questions and defining key terms, the chapter concludes with a review of the limitations, delimitations, and conceptual assumptions of this dissertation.

There exists a long-standing discussion about how best to educate students. This discussion is multifaceted and it is particularly contentious regarding what students learn in the science classroom. A major socio-scientific controversy pertains to the theory of evolution by natural selection and its inclusion in science curriculum (Wiles, 2010). “Evolution, defined narrowly, is the scientific principle that the diversity of life on earth has arisen via descent with modification from a common ancestry” (Wiles & Alters, 2011, p. 2559). It can also “refer to a cumulative change in the natural world over time” (Scott, 2004, p. 23). Dobzhansky (1973) wrote “nothing in biology makes sense except in the light of evolution” (p. 125). Although evolution by natural selection is a largely accepted fact among the scientific community, the understanding and acceptance of evolution and its associated concepts is problematic among the general public (Bishop & Anderson, 1990; Gregory, 2009; Nehm & Reilly, 2007; Opfer, Nehm, & Ha, 2012).

There is a significant gap between what the scientific community accepts and understands regarding evolution and what the public accepts and understands regarding it. This disconnect has been noted by numerous scientists and has not significantly improved over the last several decades (Branch & Scott, 2008; Miller, Scott, & Okamoto,

2006; Wiles & Alters, 2011). The public's lack of acceptance and understanding of evolution has far-reaching effects in areas such as research funding, academia, and general scientific literacy (Alters & Nelson, 2002). If one goal of our educational system is to produce scientifically literate individuals, we must examine the methods and underlying principles that we have used to achieve this goal.

There does appear to be a relationship between some academic (e.g., experience with science and understanding of evolution) and non-academic factors (e.g., demographics variables) and the acceptance of evolution. Several studies have demonstrated a negative correlation between religiosity (the degree to which one considers themselves to be religious) and the acceptance of evolution (Brown, 2015; Cotner, Brooks, & Moore, 2010; Rice, Olsen, & Colbert, 2011). Multiple studies have shown a positive correlation between logical thinking skills and the acceptance of evolution (Lawson & Thompson, 1988; Lawson & Weser, 1990; Lawson &Worsnop, 1992; Woods & Scharmann, 2001). Furthermore, other scholars have suggested that critical thinking is essential to understanding and accepting evolution (Alters & Nelson, 2002; Pigliucci, 2007). One study found that students who are cognitively more flexible and understand that knowledge is dynamic are more likely to accept evolution (Sinatra, Southerland, McConaughy, & Demastes, 2003). Comprehension of the changeable nature of knowledge has been found to be positively correlated with a greater acceptance of human evolution (Sinatra et al., 2003). Wiles and Alters (2011) contended that this finding supports previous ideas (Lawson, 1993) about the relationship between students' cognitive disposition and learning.

Because disposition, religious beliefs, and level of education appear to correlate with the acceptance of evolution (see Heddy & Nadelson, 2013 for a review), questions are raised regarding how individuals who accept evolution differ from those who reject evolution. This is of particular interest relative to students, as insight into factors related to their attitudes towards evolution could help improve the learning of evolution within our education system.

The Problem and Its Explication

The scientific community accepts evolution as the explanation for the diversity of life on the planet that we see today (InterAcademy Panel, 2006; Wiles, 2010). Evolution is the only scientifically supported and evidence-based explanation for the origin of new species and changes within species -- there are no alternatives (American Institute of Biological Sciences, 1994; National Association of Biology Teachers, 2011; National Science Teachers Association, 2013). Although scientists may debate the different mechanisms of evolution and the impacts of those mechanisms, that debate does not extend to the relevance or veracity of evolution (Wiles, 2010). Because evolution is central to biology, it is essential to scientific literacy (American Association for the Advancement of Science [AAAS], 1990, 1994), and higher education in biology (Alters & Nelson, 2002).

Despite the fact that scientists overwhelmingly accept evolution, it is controversial within the public at large -- especially with regard to the role it plays within science education (Mooney & Nisbet, 2005; Moore, 1991; Wiles, 2010). Although the theory of evolution by natural selection is based on the assertion that the diversity of life

we see today is the result of many small changes over time, guided only by the environment and random chance, intelligent design (I. D.) theorists (a type of creationism) have argued that the natural world must have had a designer (supernatural or extraterrestrial) and cannot be due to random chance (Behe, 1996; Dembski, 1998; Johnson, 1999). This difference between what scientists understand and what the public believes is particularly noticeable in the United States, which has a low rate of acceptance of evolution among developed nations of the world (Miller, et al., 2006; Duffy, 2011). The various factors that are thought to be associated with student acceptance of evolution have been grouped into nonreligious and religious factors (Alters & Alters, 2001; Wiles & Alters, 2011). Among the nonreligious factors are those that are scientific, including knowledge of evolutionary theory, knowledge of evolutionary evidence and origins of life, understanding the nature of science (NOS), and understanding of evolutionary mechanisms. Nonreligious, nonscientific factors include social and emotional factors, critical thinking skills, epistemological views, cognitive dispositions (i.e., how well students understand the dynamic nature of knowledge), and demographic factors (e.g., political views and academic achievement). Religious factors can be distilled into the following four ideas: (a) religious belief and acceptance of evolution are mutually exclusive, (b) scripture is literal, (c) creationist ideas are valid, and (d) religious doctrine is scientific (e.g., intelligent design/ creation science). In this dissertation, nonreligious factors based on understanding evolution and science are of interest.

Area of Concern

Because evolution is arguably the most central concept to biology (Dobzhansky, 1973; Wiles, 2010), it is essential that our students understand what it means. In order to accomplish this goal, science education focuses largely on conceptual change to redirect student misconceptions towards more scientifically appropriate explanations (Demastes, Good, & Peebles, 1995). This can be achieved through constructivist methodologies which emphasize that the ability to construct a concept is largely dependent on an individual's ability to create and evaluate different propositions (Tobin, Tippins, & Gallard, 1994).

In national polls, typically 45%-50% of Americans reported not accepting the theory of evolution by natural selection (Miller et al., 2006; The Gallup Poll, 2014). Alternative understandings and misconceptions regarding natural selection can be difficult to change (Anderson, Fisher, & Norman, 2002). Exposure to lessons on the NOS is important when considering vernacular misconceptions, such as the definition of the term 'theory' (Backhus, 2004).

Although Alters and Nelson (2002) noted that in the prior decade the academic community had made significant strides in drawing attention to the teaching and learning of evolution, the results were somewhat dismal: the public still demonstrated poor understanding of evolution. Previous studies have indicated that people may perceive human evolution differently from the evolution of other organisms (Evans, 2008; Sinatra et al., 2003). Furthermore, national polls have revealed that there may be a difference in acceptance when people are asked specifically about human evolution: 19% of people

surveyed accepted evolution as the explanation for the existence of humans (The Gallup Poll, 2014) and 33-42% believed a creationist view of human origins (The Gallup Poll, 2014; The Pew Research Center, 2013). Nadelson and Southerland (2012) suggested that more research specifically examining the acceptance of human evolution is needed to further understand acceptance of evolutionary theory.

Additionally, there is inconsistent evidence regarding the relationship between understanding evolution and acceptance of the theory. Some researchers have found that understanding is positively correlated with the acceptance of evolution (Rice, et al., 2011; Rutledge & Warden, 1999, 2000; Trani, 2004) whereas others have found no such relationship (Bishop & Anderson, 1990; Demastes, et al., 1995; Ingram & Nelson, 2006; Lord & Marino, 1993; Sinatra et al., 2003). This inconsistency presents an interesting opportunity to examine this issue among community college students.

Finally, research indicates that there is a positive relationship between understanding the NOS and accepting evolution (Johnson & Peeples, 1987; Lombrozo, Thanukos, &Weisberg, 2008) and that enhancing student understanding of the NOS may affect acceptance of evolution (Bybee, 2004; Cavallo & McCall, 2008; Dagher & BouJaoude, 1997). Indeed, Cavallo, White, and McCall (2011) found that high school students who possessed a more accurate understanding of the NOS also were more likely to accept evolution. This study will explore this relationship among community college students.

Purpose of the Study

The first goal of this dissertation is to review the research that has been conducted to examine these academic factors (e.g., understanding of the NOS, understanding of evolution, experience with science) and their relationship to the acceptance and/or understanding of evolution among students. From this review, it will become apparent that, although there is ample research on the populations of high school students, university students, and the general public, very little research has been conducted relative to community college students. This study will examine (a) whether relationships exist between several ideas (acceptance of evolution, understanding of evolution, understanding of the NOS, and acceptance of human evolution), and (b) the nature of those relationships.

Importance of the Study

This study is important not only because evolution is so widely accepted among scientists, but also because evolution is the underlying framework of biology. As such, it is an essential part of the Next Generation Science Standards (NGSS Lead States, 2013) which have been put forward by stakeholders in education (e.g., state governments, science research associations, and educators) as a guiding framework for science education. Furthermore, Vision for Change in Undergraduate Biology Education (2011), a guiding document for college biology instructors, identified understanding evolution as a core concept and understanding the NOS as a core competency, underscoring the importance of these topics.

The population in question is important to study because a large portion of the United States is enrolled in community college. As of fall 2012, 12.8 million students were enrolled in the 1,132 community colleges across the nation (American Association of Community Colleges, 2014). Community college students represent a broad range of ethnicities as well as ages, from 18 through late adulthood, with 57% of students between the ages of 22 and 39 (American Association of Community Colleges, 2014). Hundreds of thousands of degrees and certificates are awarded each year to community college students (American Association of Community Colleges, 2014). However, based on a search of the literature, this population appears to be relatively unstudied with regard to their views towards evolution.

Because most students go through the K-12 public school system (which typically includes science standards about evolution), students should have some understanding of evolution upon entering community college life sciences classes. This is not yet apparent, given the limited number of studies conducted with the population. Gaining greater insight into the acceptance and understanding of evolution among community college students may help science educators to refine educational strategies and, in turn, promote a more scientifically literate population.

Definitions

The definitions for key terms central to this dissertation are as follows:

Acceptance (of evolution): "a personal assessment of the validity of a construct [evolution] based on an evaluation of evidence" (Wiles, 2008, p. 21).

Community college: Although the Merriam-Webster (2015) dictionary Web site defined community college as “a school that you go to after high school: a school that offers courses leading to an associate's degree,” I broaden this definition as the identity of community colleges in California is changing to also include continuing education students not pursuing degrees, vocational education, high school students, and students of diverse ages and educational backgrounds.

Creationism: Creationism can be defined as “the idea of creation by supernatural force” (Scott, 2009, p. 57). It includes the narrower doctrine of “special creationism: that God created the universe essentially as we see it today, and that this universe has not changed appreciably since that creation event… God created living things in their present forms” (Scott, 2009, p. 57).

Creationist: The National Academies of Sciences Web site (2013, para. 2) defined a creationist as “someone who rejects natural scientific explanations of the known universe in favor of special creation by a supernatural entity.”

Evolution: The National Academies of Sciences Web site (2013, para. 4) defined evolution as consisting “of changes in the heritable traits of a population of organisms as successive generations replace one another. It is populations of organisms that evolve, not individual organisms.”

Human evolution: The Smithsonian Museum of Natural History Web site (2016, para. 1) defined human evolution as “the lengthy process of change by which people originated from apelike ancestors. Scientific evidence shows that the physical and behavioral traits shared by all people originated from apelike ancestors and evolved over

a period of approximately six million years." In this dissertation, 'evolution' will refer to evolution in general, whereas 'human evolution' will apply to a specific subset of evolution (involving humans).

Intelligent design: Scott (2009) stated, "intelligent design proponents posit that the universe, or at least components of it, have been designed by an 'intelligence.' They also claim that they can empirically distinguish intelligent design from design produced by natural selection" (p. 123). Supporters of intelligent design "propose a new kind of science: theistic science… allowing explanation by supernatural causes" (p. 130). Based on the inclusion of supernatural causes, intelligent design falls under creationism, not science.

Life sciences: Merriam Webster online dictionary (2015) defined the discipline as "branch[es] of science (as biology, medicine, and sometimes anthropology or sociology) that deals with living organisms and life processes." For the purposes this study, life sciences will include biology and specialties of biology (e.g., health sciences, marine biology).

Nature of science: The National Science Teachers Association Web site (NSTA, 2000, para. 1) defined the NOS in the following way:

> All those involved with science teaching and learning should have a common, accurate view of the nature of science. Science is characterized by the systematic gathering of information through various forms of direct and indirect observations and the testing of this information by methods including, but not limited to,

experimentation. The principal product of science is knowledge in the form of naturalistic concepts and the laws and theories related to those concepts.

Science: The National Academies of Sciences Web site (2013, para. 18) defined science as “the use of evidence to construct testable explanations and predictions of natural phenomena, as well as the knowledge generated through this process.”

Theory: The National Academies of Sciences Web site (2013, para. 24) defined theory as “a plausible or scientifically acceptable, well-substantiated explanation of some aspect of the natural world; an organized system of accepted knowledge that applies in a variety of circumstances to explain a specific set of phenomena and predict the characteristics of as-yet-unobserved phenomena.”

Research Questions

This dissertation explores one primary question and three secondary questions.

Primary Question:

To what extent does a relationship exist between the acceptance or rejection of biological evolution by community college students and selected academic science-oriented factors (i.e., how well do they understand evolution and the NOS)?

This dissertation also poses the following secondary research questions, intended to explicate the primary research question:

Secondary Questions:

1. Is there a difference between the level of acceptance of evolution and the level of acceptance of human evolution?

2. Is there a relationship between the level of acceptance of evolution and the level of understanding the NOS?
3. Is there a relationship between the level of acceptance of evolution and the level of understanding of biological evolution?

Delimitations

I have identified potential threats to the internal and external validity of this study. First, the study is limited by the population of the participants. Because participation was voluntary, there may be some self-selection that takes place and students who reject evolution may have chosen not to participate in the study. In addition, I collected data from only one school in Southern California. The population I surveyed may not be representative of the community college population as a whole, either in Southern California, or the United States of America.

Second, the instrument used in this study was a combination of different parts of existing instruments. I assessed acceptance of evolution using the Measuring Attitudes Towards Evolution (MATE) instrument (Rutledge & Sadler, 2007; Rutledge & Warden, 1999), which has been well validated. I did, however, also include select items from the following existing measures: the Inventory of Student Acceptance of Evolution (I-SEA) (Nadelson & Southerland, 2012), a relatively new instrument; the Evolutionary Attitudes and Literacy Survey short form (EALS-SF) (Short & Hawley, 2012), a well-tested instrument; and the Life Science Conceptual Inventory (LSCI) assessment (Sadler, Coyle, Smith, Miller, Mintzes, Tanner, & Murray, 2013), which has been well validated among middle school students. Because I used select items to address specific issues, the

reliability and validity of each instrument may no longer hold. In addition, none of these instruments have been validated with community college students, so it may be that the instrument I used may not accurately measure the concepts I studied. I address these issues in Chapters 3, 4, and 5.

Limitations

Due to the diverse nature of the participant population, it may be that unmeasured factors could have influenced the results (e.g., religious beliefs, political views, and socioeconomic status). In addition, the internal validity would be threatened if any of the methodological assumptions or conceptual assumptions explained below were not met.

Conceptual Assumptions

One assumption underlying this research was that acceptance of evolution -- not just the understanding of evolution -- is a goal of science education. Although there has been debate regarding this issue (Alters, 1997; Kearney, 1999; Nehm & Schonfeld, 2007), the overwhelming majority of scientists and scientific organizations express that biology, and indeed many areas of science, cannot be properly understood unless viewed within the context of evolution. Student understanding of evolution is clearly a goal of education, and may be more important than acceptance of evolution (Ingram & Nelson, 2006). However, as research has shown that a lack of acceptance of an idea can inhibit understanding of that idea (Cobern, 1994; Meadows, Doster, & Jackson, 2000; Scharmann, 1990; Smith, 1994), I operated under the assumption that acceptance of evolution is an important goal of science education. Furthermore, as scientists do not view humans as being exempt from evolutionary processes (although many in the public

may [The Gallup Poll, 2014; Sinatra et al., 2003]), I assumed that the acceptance of human evolution is also a goal of science education. As a college biology professor, I also acknowledge my own bias that acceptance and understanding of evolution (and human evolution) are important for science education.

In addition, I assumed the instrument that I compiled for use in this dissertation allowed me to detect whether participants accept or reject evolution, understood evolution, accept or reject human evolution, and understood the NOS. Although each portion of my survey has been validated on its own within its existing framework, using the items separate from the rest of the respective instruments could reduce their reliability and validity. Despite this limitation, each of the items were rationally chosen specifically because of their assumed value in assessing a particular construct under inquiry in this study. To ensure reliability and validity, I had experts review them for content and had students review them for readability. I also calculated statistical reliability for each portion of the survey.

Outline of the Remainder of the Dissertation

The remainder of this dissertation is divided into four chapters. Chapter 2 consists of a literature review examining factors associated with acceptance of evolution and studies conducted with community college students, thereby providing the rationale for this study. Chapter 3 outlines the methods that were followed in order to conduct this study, including a discussion of the development of the instrument used and data analysis strategies employed. Chapter 4 displays the results of this dissertation. Chapter 5 concludes the dissertation with a discussion of those findings, how they fit within the

greater context of evolution and science education, acknowledgement of the limitations of this study, and recommendations for future research.

Chapter 2: Literature Review

In this chapter I provide a selective review of of the literature in which I explore research that has examined the relationship between the acceptance of evolution among college students in the United States and the following factors: the influence of student understanding of the nature of science (NOS), understanding of evolution theory, and knowledge of the evidence of evolution and evolutionary mechanisms as it relates to acceptance. I also explored other nonscientific factors, including demographic factors and epistemological views. I conclude with a discussion of the few research studies examining evolutionary beliefs among community college students that I was able to find in the literature.

From this review, it will become apparent that although there is ample research on the populations of students at four-year colleges and universities, very little research has been conducted with community college students. As noted in the introduction, understanding evolution is essential to scientific literacy -- especially at the level of higher education -- to make informed decisions in our everyday lives. Therefore, understanding how students come to accept or reject evolution is crucial to addressing the issue of the acceptance of evolution.

Literature Inclusion Criteria

As previously mentioned, this is a selective review of the literature. To access the literature, I searched several databases including: Academic OneFile - Gale Cengage, EBSCO, ERIC, Web of Knowledge - ISI Thomson Scientific, and JSTOR. I initially limited the search to work published between 1995 and 2015 so as to capture the most

recent data. However, my initial search led me to broaden my scope to include earlier research that was of a seminal nature or offered insight into the issue that subsequent research had not addressed. I used search terms including but not limited to the following: the acceptance of evolution, understanding the NOS, human evolution, measuring acceptance, measuring understanding, students, community college, junior college, university, and undergraduate. Publications were only included if they could shed light on the topic at hand, and I focused my review on undergraduate students whenever possible.

Selective Literature Review of Factors Related to Student Acceptance of Evolution

In this section, I review the literature on factors that are related to student acceptance of evolution. Specifically, I describe the importance of understanding the NOS, previous experience with biology, demographic and religious factors, evolution understanding, and epistemology. I conclude with a review of the research that has examined the acceptance of evolution and understanding among community college students.

Understanding of the Nature of Science

Student understanding of the NOS may be linked to the acceptance of evolution (Allmon, 2011; Carter & Wiles, 2014; Sinatra et al., 2003; Smith, 2009; Southerland, Sinatra, & Matthews, 2001). NOS deals with "the philosophy of science including how scientific knowledge is generated and how science progresses" (Carter & Wiles, 2014, p. 3). Essentially, understanding the NOS means understanding how scientists 'do' science: how they engage in the process of scientific inquiry, how they evaluate evidence, and

how they come to consensus regarding explanations and theories for that evidence. A crucial piece of understanding the NOS is the recognition that although scientific theories are robust and well supported, science is a self-correcting process (Grinnell, 2009). In particular, relative to evolution education, a greater understanding of the NOS may increase student acceptance of evolution because it may allow them to develop an understanding of how scientists evaluate evidence and develop consensus within the scientific community (Carter & Wiles, 2014).

Carter and Wiles (2014) examined the relationship between student understanding of the NOS and two socially controversial topics: biological evolution and global climate change. The authors chose evolution and climate change in part because some educators reported being less likely to address these issues in class because of their socially controversial nature (Reardon, 2011). Carter and Wiles (2014) also noted the similarity in the scientific and nonscientific factors that affect views on global climate change to those for evolution. The authors used previously tested and robust measures of student understanding of the NOS and levels of acceptance of evolution (the Thinking about Science Survey Instrument [Cobern, 2000], and the Measure of Acceptance of the Theory of Evolution [MATE] [Rutledge & Sadler, 2007; Rutledge & Warden, 1999], respectively). In the absence of a tested measure of attitudes towards global climate change, the authors developed their own measure based on opinion polls and included questions about demographic factors that might affect student attitudes toward evolution or global climate change.

Carter and Wiles (2014) found that, among a group of university introductory biology students (N = 620), the students expressed a somewhat higher level of acceptance of evolution than the general public (60% versus less than 50%), as well as greater concern for global climate change. Perhaps this result was because the participant population consisted of private university students in the northeastern United States of America, whose demographics may not be representative of the general public. In addition, when students were surveyed at the beginning of the course and at the end of the course, increases in the acceptance of evolution were significantly and positively correlated with increases in understanding the NOS ($r = 0.35$, $p < 0.001$) and the understanding of evolutionary science ($r = 0.35$, $p < 0.0001$), although the correlations were moderate. In contrast, acceptance of evolution was significantly and moderately negatively correlated with religiosity ($r = -0.32$, $p < 0.0001$). These results further supported previous research findings (discussed in the next section) that knowledge of evolutionary science (after course completion) was positively correlated with the acceptance of evolution (Wiles & Alters, 2011). Carter and Wiles (2014) concluded that changes in the acceptance of evolution correlated positively with changes in understanding the NOS, which has implications for evolution education. In other words, increasing student understanding of the NOS may help students to accept evolution.

In another study, Rutledge and Sadler (2011) examined the connection between student acceptance of evolution, as well as other less controversial scientific theories, and their understanding of the NOS. Their interest in this study arose in part from understanding that knowledge about the NOS can play an important role in making

informed decisions within society (Lederman, 1999). Rutledge and Sadler surveyed a group of college biology students (nonmajors) on the first day of class (N = 172). Their survey examined student acceptance of five general scientific theories (i.e., gene, cell, germ, atomic, and evolution), their understanding of the NOS, and their acceptance of evolution (using the MATE instrument noted above). Because the goal of this study was to examine student knowledge and opinions before instruction, the study did not employ a pretest and post-test method.

The findings indicated that student acceptance of evolution was significantly lower than their acceptance of the other scientific theories ($p < 0.001$, Wilcoxon Signed Rank Test). In addition, student understanding of the NOS did not correlate significantly with any of the theories (r values ranges from -0.026 to 0.083, $p \geq 0.280$). The authors asserted that these results indicated that evolution is different from other theories in biology, especially in student attitudes towards it and acceptance of it.

Acceptance of evolution may also predict an understanding of the NOS. Partin, Underwood, and Worch (2013) administered a survey to approximately 200 biology students: 150 nonmajors and 50 majors (sample size varied with the question asked). The survey assessed attitudes towards evolution and biology, and understanding of natural selection and the NOS. The authors also asked a question about religiosity and a question about the level of parents' education. They found that biology majors had a significantly greater understanding of the NOS (t (200) = -3.002, $p < 0.003$) and acceptance and understanding of evolution (natural selection) than nonmajors (t (200) = -3.578, $p < 0.001$, and t (199) = -8.986, $p < 0.001$). In addition, regression analysis revealed that

among nonmajors, knowledge of natural selection ($\beta = 0.201$), acceptance of evolution ($\beta = -0.224$), attitudes towards biology ($\beta = 0.278$), and level of parents' education ($\beta = 0.193$, $R^2 = 0.241$) predicted understanding of NOS. Among majors, only knowledge of natural selection ($\beta= 0.389$) and acceptance of evolution ($\beta= 0.395$, $R^2 = 0.428$) significantly predicted understanding of the NOS. Cohen's f^2 measure indicated the magnitude of the effect size was medium for nonmajors (0.318) and large for majors (0.748).

The results of these three studies (i.e., Carter & Wiles, 2014; Partin et al., 2013; Rutledge & Sadler, 2011) indicated that education and instruction in evolution and the NOS may play a role in student acceptance of evolution. The first and third studies (i.e., Carter & Wiles, 2014; Partin et al., 2013) examined this explicitly, whereas the second study (Rutledge & Sadler, 2011) examined only the knowledge with which a student entered a course; as that knowledge changes, it may be possible to alter the acceptance of evolution.

Previous Experience with Biology

Because of the role that education may play in the acceptance of evolution, it is important to examine studies that assess the relationship between prior knowledge and previous coursework on acceptance and understanding of evolution. In one study, Moore and Cotner (2009) assessed whether biology majors were more likely to accept evolution than nonmajors. They also considered whether each group had been taught evolution or creationism in high school biology courses and whether those teachings may have influenced their attitudes towards evolution. These questions are relevant as 27% of first

year college students surveyed in a previous study (N = 1,465) reported that their high school biology teachers included creationism in their classes (Moore, 2008).

Moore and Cotner (2009) surveyed more than 1000 introductory biology students. Their survey included the use of the MATE, classification as biology major or nonmajor, and questions about high school biology classes. They found that 64% of the students were taught evolution (and not creationism) in their high school biology courses and 1-2% were taught creationism only. More biology majors (29%) had high school biology classes that included both evolution and creationism than did nonmajors (21%). As far as their acceptance of evolution, nonmajors were more likely to view evolution as speculative (26.5% versus 13.5% of the majors, $p < 0.0001$) whereas majors were more likely to view evolution as unifying biology (74.2% versus 66.5% of the nonmajors, $p < 0.01$). Interestingly, both majors and nonmajors who were taught creationism in high school biology classes, regardless of the inclusion of evolution, displayed a higher rate of acceptance of creationism-based responses within the MATE than those who only learned evolution. It should be noted that the differences in responses were not statistically analyzed for significance. However, using a portion of the results the authors published, I calculated the average difference in the percentage of students who agreed with creationism-based statements based on whether they had been taught creationism in high school. On average, 16% more students agreed with creationism-based statements on the MATE if they were taught creationism in high school.

Biology major students were more likely than their nonmajor counterparts "to accept the claim that the data are unclear as to whether evolution actually occurs" (Moore

& Cotner, 2009, p. 430). In addition, biology-major students offered voluntary comments endorsing creationism at twice the rate of evolution. The authors interpreted these results to mean that many biology majors accepted creationism, in part because high school-level instruction evolutionary biology was highly flawed (Rutledge & Mitchell, 2002). They attributed those flaws to lack of proper presentation of evolution or the NOS and to introducing creationism as a valid scientific theory. Moore and Cotner (2009) also concluded that, the decision to major in biology did not appear to be related to experience with evolution in high school biology courses. Moore and Cotner asserted that biology teachers may include creationism in their courses for the following reasons: poor understanding of evolution on the part of the teacher, the religious beliefs of the teacher, pressure from external sources (such as parents), lack of consequences, and ignorance of the ruling made by a federal court that disqualifies intelligent design (a form of creationism) from being taught in high school science classes (Tammy Kitzmiller et al. v. Dover Area School District, 2005).

In another study, Paz-y-Miño and Espinosa (2009) compared attitudes towards evolution, creationism, and intelligent design (a form of creationism) between students at a secular college and at a religious college. Although they did not examine prior exposure from high school, they did focus on the progression in acceptance of evolution from first-year to senior year as students took biology courses. Their methods differed significantly from other studies in that they did not employ a previously validated quantitative measure (e.g., MATE). Instead, they asked students (religious n = 355, secular n = 476) six

questions regarding evolution, creationism, and intelligent design with five possible answers to each question.

The authors found that, at both institutions, the majority of biology majors believed that evolution should be taught in science classes (combined mean = 64%). Among nonmajor students, proportionally more of the students from the religious college supported teaching evolution exclusively (not creationism) in science classes (42% secular versus 62% religious). In addition, the findings revealed that the acceptance of evolution among biology majors at both colleges increased throughout the course of the college experience (18% more of seniors accepted evolution than did first-year students). The authors attributed that shift to students being exposed to more evolutionary content in upper division courses. It should be noted that the authors did not track the acceptance of evolution among students throughout their college career, but rather compared results among different samples of first-years and seniors. The authors suggested that students come to college poorly prepared to study science but that increased instruction in evolution was effective in increasing acceptance; this conclusion was also supported by other researchers (Ingram & Nelson, 2006; Matthews, 2001; Robbins & Roy 2007).

In a small study of 31 nonmajor biology class students, Scharmann and Butler, Jr. (2015) integrated the use of journaling -- specifically about attitudes towards and understanding of evolution -- throughout the course. Journals were evaluated by instructors and 10 random entries were submitted to an observer to ensure a 90% or higher agreement on the scoring of the entry. They found that, over time, student responses became more informed and more positive towards evolution. From week 1 to

week 13, the journal entries became significantly more favorable towards evolution, more closely reflecting the views held by scientists, X^2 (5, N =31) = 104.18, $p < 0.001$. Although the sample size is small, this study adds support to the idea that instruction and/or experience with biology can increase acceptance of evolution.

In a similar vein, Infanti and Wiles (2014) administered the Evolutionary Attitudes and Literacy Survey (EALS) (Hawley, Short, McCune, Osman, & Little, 2011) to 117 introductory biology students at the beginning and end of the course. Half the students (enrolled in separate lab sections) were given four assignments throughout the semester that exposed them to evolution in the news. Students who were exposed to evolution in the news scored significantly higher on the relevance of evolutionary science than the students who did not have those additional activities ($t = 2.177$, $p = 0.041$). The authors contended that explicitly addressing the relevance of evolution in a course can lead to better understanding and higher acceptance of evolution.

Although these and other studies of university students have shown significant changes in acceptance of evolution as a result of course instruction (Ingram & Nelson, 2006; Wilson, 2005), other studies have not (Bishop & Anderson, 1990; Lawson & Worsnop, 1992). Wiles and Alters (2011) critically noted that in many of these studies the researchers focused on a very small number of potentially influencing factors. To address this discrepancy, Wiles and Alters offered a study considering multiple factors, using pre- and post-instruction measurements, and employing the MATE instrument (Rutledge & Sadler, 2007; Rutledge & Warden, 1999). They surveyed 81 upper-level high school students in Arkansas before and after they attended a summer program in

natural sciences. The researchers found significant increases in acceptance of evolution ($t = 11.242$, $p < 0.001$) and a longitudinal aspect of their study (n = 37) showed that those increases in acceptance were sustained through the following year. In this case, the summer course in which the students participated was "designed to incorporate an inventory of factors which were suspected to influence student acceptance of evolution" (Wiles & Alters, 2011, p. 2580) (e.g., religious views, misconceptions about evolution based in physics, understanding of evolution, and critical thinking skills). It is unclear which factors had the greatest effect; however, the fact that the course appeared to affect change in the acceptance of evolution may offer insight into how a constructivist pedagogy (as previously described) could be used within the classroom to enhance learning.

More recently, Short and Hawley (2015) administered the Evolutionary Attitudes and Literacy Survey (EALS) (Hawley et al., 2011) to 868 undergraduates who were enrolled in one of three classes: introduction to organismal biology or evolutionary psychology (both of which have a focus on evolution) or political science (course content is unrelated to evolution). The 437 students in the introduction to organismal biology course had all completed a previous biology course as a prerequisite; students enrolled in the other classes did not have a similar prerequisite. The survey was given to students at the beginning and end of the course to examine how exposure to course material might have affected their score on the EALS.

Short and Hawley (2015) found that knowledge of evolution did not change significantly for students in the biology course (ΔX^2 (1) = 3.64, $p = 0.06$), but students'

knowledge in both the political science (ΔX^2 (1) = 6.93, $p < 0.01$) and the evolutionary psychology classes (ΔX^2 (1) = 11.98, $p < 0.001$) did change significantly, with small and moderate effect sizes ($d = 0.13$, $d = 0.51$). Additionally, whereas evolutionary misconceptions significantly decreased over time in the evolutionary psychology course, $X^2(1)= 11.51$, $p < 0.001$, with a moderate effect (d = -0.47), they increased significantly in the biology students, $X^2(1) = 30.70$, $p < 0.001$, with moderate effect size (d = 0.42). There was no significant change among the political science students.

Based on their results, Short and Hawley (2015) suggested that increased knowledge of evolution does not preclude students from retaining or even gaining new misconceptions about evolution. Furthermore, completing a biology course does not necessarily confer accurate understanding of evolution. Thus, the relationship between evolution understanding and the acceptance of evolution is further complicated by the fact that knowledge of evolution can be fraught with misconceptions.

Demographic and Religious Factors

Along with previous exposure to evolution and/or creationism, religion and politics can play a role in determining whether students accept evolution. Cotner et al. (2010) examined the relationship between previous biology experience (i.e., from high school), basic demographic information such as religion and politics, and acceptance of both evolution and the age of the earth. The researchers utilized the MATE survey and a Knowledge of Evolution Exam (Moore, Cotner, & Bates, 2009), and electronically surveyed 400 students before the beginning of a nonmajors biology class. Students self-identified as politically liberal, conservative, or "middle-of-the-road," or none of the

above and religiously conservative, “middle-of-the-road,” liberal/progressive, or none of the above. The results of structural equation modeling indicated that political views were significantly linked to religious views ($p < 0.001$). Specifically, individuals with more liberal political views were more likely to hold liberal religious views and vice versa. Religious views were strong predictors of knowledge of evolutionary theory and beliefs about the origins of the world ($p > 0.05$). More liberal students were more likely to answer questions about evolution correctly than those who were more conservative ($p < 0.05$).

In addition, more liberal political views disposed students to accept the scientifically held age of the earth (Cotner et al., 2010). Accepting the age of the earth is important because it may increase the ability of students to understand evolutionary theory. Also, data gathered about exposure to evolution in high school confirmed the results of the previously discussed study (Moore & Cotner, 2009) in that students who were exposed only to evolution (and not creationism) in their high school biology classes were significantly more likely to correctly answer questions about evolution. In summary, students who learned evolution only in high school and were politically and religiously liberal were more likely to score higher on the survey than students with more conservative backgrounds (Cotner et al., 2010).

Cotner et al. (2010) inferred four major ideas based on their research and review of the literature:

> (1) deep time is conceptually difficult to grasp… (2) students’ inability to accept an old Earth is a barrier to evolution acceptance… (3) creationists’ explanations

> for life's origins are easier to teach, learn and internalize than are scientific explanations that rely on our understanding of deep time… (4) teaching about time requires teaching for conceptual change. (pp. 861-862)

Each of these challenges could be taken into account when attempting to improve evolution instruction.

Rice et al. (2011) also examined the correlation between biology majors' knowledge and attitudes towards evolution and their theistic position (as measured by students answering questions about their perceived position as a creationist or evolutionist), to explore whether evolution education changed that position. The authors also reported on previous studies that had examined the rate of acceptance of evolution. Their report included studies with high school biology teachers, college students, adults, and Christian clergy and found that from 30 to 74% of the individuals studied held creationist positions (Barnes, Keilholtz, & Alberstadt, 2009; Brehm, Ranney, & Schindel, 2003; Colburn & Henriques, 2006; Ingram & Nelson, 2006; Losh & Nzekwe, 2010; Miller, et al., 2006; Moore & Kramer, 2005; Verhey, 2005;). Rice et al. (2010) noted that because the majority of these studies looked at a snapshot of information, employing a pre- and post-course survey in future research would be informative in determining whether biology instruction resulted in a higher understanding and acceptance of evolution. Previous studies indicated that using explicit evolution education in biology classes resulted in a change in understanding and acceptance of evolution (Martin-Hansen, 2008; Robbins & Roy 2007).

Rice et al. (2011) surveyed biology majors who were either first-year students or graduating senior students on a 15-item survey that assessed basic knowledge of evolution, attitude towards evolution and creationism, and understanding of the NOS. First-year students were surveyed at the beginning (n = 82) and the end of the course (n = 122), and senior students (n = 61) were surveyed only towards the end of their coursework, near graduation. First-year student scores on evolution knowledge improved after instruction, $F(2, 262) = 52.58$, $p < 0.001$, whereas seniors had the highest understanding of evolutionary concepts ($p < 0.01$).

Interestingly, the theistic position of the students did not differ across groups, even though students who completed more coursework understood and accepted evolution at a higher rate than students with less instruction (Rice et al., 2011). First-year students did not change their theistic position significantly after coursework in evolution and both seniors and first-year students held similar theistic views even though the seniors had exposure to more evolutionary coursework. The students who identified as being evolutionists experienced a greater increase in understanding of evolution and more positive attitudes towards evolution than those students who identified as having a more creationist theistic position (although the creationist students also experienced an increase in understanding of evolution and positive attitudes towards evolution). The results of this study indicate that regardless of theistic position, it is possible for students to learn to understand and potentially accept evolution.

Understanding versus Acceptance and Epistemology

It is here that we transition into a discussion of how epistemological stance (i.e., conceptions of knowledge) and disposition (e.g., learning style, need for cognition, and temperament) can shape the acceptance of evolution and understanding. In order to discuss the relationship between understanding and acceptance with regard to biological evolution, it is important to understand what these terms mean. Among the scientific community, knowledge is considered to be a true belief that is justifiable by evidence (Siegel, 1998); "*beliefs* are understood to be a subjective way of knowing" (Sinatra et al., 2003, p. 511). Thus, in science, educators distinguish between accepting a construct and believing in that construct. The use of correct terminology is important because laypeople may view a belief in evolution as suggesting that it is a subjective viewpoint, based on personal convictions, rather than as a systematic evaluation of evidence (Smith, 1994; Smith & Scharmann, 1999; Smith, Siegel, & McInerney, 1995).

There is some controversy in the field of education regarding the relationship between acceptance and understanding. Smith (1994) contended that developing the understanding of a construct in science can be hindered by the failure to accept that construct. Some researchers have argued that it is essential to address the idea of student acceptance of evolution before students will be able to learn about the construct (Cobern, 1994; Jackson 2000; Meadows et al., 2000; Scharmann, 1990; Smith, 1994). Alternatively, other researchers proposed that acceptance of the theory is predicated on understanding it (Lawson & Weser, 1990; Lawson & Worsnop, 1992). Lawson and Worsnop (1992) surveyed 107 high school students and conducted a path analysis to

examine relationships between the acceptance of evolution, knowledge, reasoning skill and beliefs. They found that, in general, individuals who were better skilled at reasoning were also more likely to accept and be committed to evolutionary statements ($r = 0.36$, $p < 0.001$).

Whereas the aforementioned researchers suggest a relatively straightforward connection between knowledge and acceptance, other findings have indicated the relationship is not as clear. Several studies did not find any relationship between understanding of evolution and student acceptance of evolution (Bishop & Anderson, 1990; Demastes-Southerland, Settlage & Good, 1995; Lord & Marino, 1993). In addition, researchers have found that students with creationist views can demonstrate sophisticated understanding of evolution and students who identify themselves as evolutionists may in turn demonstrate a poor understanding of evolutionary theory (Demastes-Southerland et al., 1995). Thus, it is unclear exactly how knowledge and acceptance influence each other.

Belief, understanding, and acceptance are related to students' epistemological beliefs, especially those about the NOS and the nature of knowledge. As discussed above, understanding the NOS can be helpful when students are learning about evolution and global climate change (Carter & Wiles, 2014). The students' epistemological beliefs appear to be related to their education (Schommer, 1993), and students are more likely to invoke their epistemological beliefs when confronted with controversial topics. Eventually, research may show that this holds true for other controversial science topics of interest. Kardash and Scholes (1996) found that those undergraduate students ($n = 96$)

whose epistemological beliefs suggested that knowledge was tentative were more likely to consider evidence to be inconclusive, whereas those who believed knowledge to be absolute were more likely to view any evidence as conclusive one way or the other, $F(1, 64) = 7.72$, $p < 0.01$.

In another study about controversial topics, Kudrna, Shore, and Wassenberg (2015) surveyed 628 non-biology major undergraduate students regarding their need for cognition (NFC) (i.e., the tendency for individuals to enjoy thinking), acceptance of anthropogenic climate change (ACC, the idea that humans are contributing to global climate change), and attitudes towards evolution. Their Likert-scaled survey consisted of five questions about NFC, four ACC questions, and seven questions from the MATE. Although some validity may have been lost by removing the survey items from their original measure, Cronbach's alphas revealed adequate to strong internal consistencies (NFC $\alpha = 0.72$, ACC $\alpha = 0.75$, and the acceptance of evolution $\alpha = 0.89$).

Kudrna et al. (2015) found small positive correlations between NFC and acceptance of ACC ($r = 0.29$) and the acceptance of evolution ($r = 0.31$), as well as a moderate correlation between the acceptance of ACC and the acceptance of evolution ($r = 0.445$). The authors concluded that factors other than NFC must also be accounting for the acceptance of these two controversial topics as the coefficient of determination was was low between all three factors (r ranged from 0.09 - 0.20).

In concert with epistemological beliefs, student disposition (i.e., personality and cognitive levels) may affect reasoning skills and problem solving, particularly with controversial topics (Stanovich, 1999). Dispositions are defined as "relatively stable

psychological mechanisms and strategies that tend to generate characteristic behavioral tendencies and tactics" (Stanovich, 1999, p. 157). Several studies have demonstrated the relationship of individual differences in disposition to problem-solving and reasoning, finding that being open-minded and having the ability to examine new evidence (regardless of whether it goes against personal belief) can lead to differences in problem-solving, irrespective of cognitive capacity (Sa, West, & Stanovich, 1999; Stanovich, 1999; Stanovich & West, 1997, 1998).

In one study, Sinatra et al. (2003) surveyed 93 undergraduate students in a nonmajors biology course for evolution understanding, epistemological beliefs, the acceptance of evolution, acceptance of photosynthesis and cellular respiration (two noncontroversial topics), disposition, and demographic information, including previous biology classes taken. The results revealed no significant relationship between the acceptance of evolution and knowledge of evolution ($r = -0.14$, $p > 0.05$), although there was a small significant relationship between knowledge and acceptance of photosynthesis and respiration ($r = 0.29$, $p < 0.05$). In addition, the epistemological sophistication of students was significantly related to their level of acceptance of human evolution as indicated by a small inverse relationship (i.e., students who were less epistemologically sophisticated were less likely to accept human evolution) ($r = -0.23$, $p < 0.05$).

In contrast, Sinatra et al. (2003) determined through regression analysis that epistemological sophistication did not predict acceptance of photosynthesis, cellular respiration, or animal evolution. Students who were more open-minded in their disposition were more likely to accept human evolution ($r = 0.32$, $p < 0.05$), but there

was no significant relationship between epistemological sophistication or disposition and knowledge of evolution. It is notable that this is one of a few studies thus far (including Evans, 2008) that specifically addressed human evolution -- as opposed to nonhuman-animal or plant evolution -- and found that disposition played a role in acceptance of human evolution over evolution in general. In addition, the Gallup Poll (2014) revealed that there may be a difference in acceptance when people are asked specifically about human evolution, rather than evolution as a whole. Nadelson and Southerland (2012) suggested that more research specifically examining the acceptance of human evolution is needed in order to further understand the acceptance of evolution.

Sinatra et al. (2003) interpreted the results of their study to mean that students can understand evolutionary theory without accepting it and vice versa. It appears that "knowledge must reach a critical level to influence student acceptance of ideas" (Sinatra et al., 2003, p. 521). The authors also suggested that when students are confronted with more controversial topics, their dispositions and epistemological beliefs more greatly affect their acceptance. The authors were careful to note that they did not have a way of distinguishing whether their acceptance measure was actually measuring acceptance as opposed to belief. They still contended, however, that the results are significant and lend support to the inclusion of more NOS instruction as a tool for evolution education.

In another study, Nadelson and Southerland (2010b) examined the relationship between acceptance and understanding of evolution but focused specifically on macroevolutionary processes (e.g., speciation, fossil evidence). The study also linked acceptance of evolution and knowledge of macroevolution to the extent of college

biology coursework taken (as studies described in previous sections of this paper have done with evolution in general). The researchers surveyed more than 600 students in a first-semester biology course (who had less than a semester of college-level biology) and 74 students from an evolutionary biology course (who, on average, had taken approximately eight and one half college biology courses). The instructors conducted MATE and Measure of Understanding Macroevolution (MUM) (Nadelson & Southerland, 2010a) surveys pre-course for the introductory biology students and pre- and post-course with the evolutionary biology students.

Nadelson and Southerland (2010b) found that the understanding of macroevolution was moderately correlated with the acceptance of evolution ($r = 0.47$, $p < 0.01$). In addition, both the knowledge and acceptance of evolution were positively correlated with the number of biology courses taken ($r = 0.27$, $p < 0.01$; $r = 0.35$, $p < 0.01$). The results also indicated that students may shift their understanding of macroevolution and acceptance of evolution throughout a single course of study. This finding, however, requires further research as the statistical methods employed did not reveal the progress or changes in specific students. The results of the study support the results of previous studies (e.g., Southerland & Sinatra, 2005) in that the relationship between knowledge and acceptance may be dependent on educational experience, as measured by the number of biology courses completed. However, this may not be the best measure of educational experience as number of courses does not include the quality of those learning opportunities.

The Acceptance of Evolution among Community College Students

This researcher was only able to find a few studies that focused on community college students and evolution education. Given the large number of community college students and the importance of evolution education for scientific literacy, this gap in the literature supports the importance of the current research. Below, I describe the methods and the results of the existing studies and critique them so as to illuminate and emphasize the necessity of further research with community college students.

McKeachie, Lin, and Strayer (2002) examined the effects of taking an introductory biology course on students' beliefs about evolution, as well as the relationship among students' beliefs and their motivation, learning strategies, anxiety, and performance in biology. The researchers surveyed students in an introductory biology course (they did not report whether the course was for majors or nonmajors). Of the 75 students in the course, 60 completed a pretest questionnaire but only 28 completed the posttest questionnaire. The surveys were not anonymous and the authors reported that, of those who did not take the posttest, the majority did not believe in evolution, as most of the students (17 out of 19 students) who dropped the course before the posttest either did not accept evolution or accepted both evolution and the Bible. Rather than using an established measure, the authors used a four-item questionnaire meant to elicit student attitudes towards evolution and creationism. The first question addressed whether students believed the theory of evolution to be true, and the second asked students whether the Bible is true and/or compatible with the theory of evolution. The third question asked students to choose whether they accepted the Bible, evolution, both, or

neither. The fourth asked how much knowledge they had about evolution. Students also completed the Motivation and Learning Strategies Questionnaire, designed to address their learning strategies and motivation (e.g., test anxiety, critical thinking, organization) (Pintrich, Smith, Garcia, & McKeachie, 1993).

The results of the study indicated that, at the beginning of the semester, most students (36.7%) stated they did not know enough about evolution or the Bible to accept either (McKeachie et al., 2002). At the end of the course, students reported changes in the direction of greater belief in evolution (39.3%). However, this result may be somewhat biased by the fact that students who did not accept evolution either failed to complete the posttest or were more likely to drop the course than the students who believed in evolution. McKeachie et al. also found that students who identified themselves as believing and accepting evolution earned better grades (final grade was a B or higher) than creationist students (the three remaining creationist students each earned the grade of C).

By the end of the semester there were only “three steadfast creationists” (McKeachie et al., 2002, p. 191) out of the 28 students remaining in the course and their beliefs did not change. Those students reported lower interest in the topic and greater motivation for grades at the beginning of the semester. They also scored lower on intrinsic motivation, task value, and self-efficacy and reported being more anxious. Finally, the creationist students did more memorization and less contemplation about ideas, and scored lower on both the thinking skills and learning strategies portion of the assessment. In contrast, the seven students who self-reported as firm evolutionists

performed in the opposite direction and the six students who went from not accepting to accepting evolution presented in the middle, with higher intrinsic interest and less concern about grades.

McKeachie et al. (2002) contended that students who believed in creationism most likely experienced cognitive dissonance (i.e., being confronted with evolution, which directly conflicted with their own beliefs), which they may have resolved either by dropping the course or declining to complete the questionnaire. Despite this finding, the creationist students in this study seemed to have an average understanding of evolution, but the authors suggested that understanding may not be the only goal; rather, a shift in attitude towards acceptance of evolution is desired. The results of this study indicated that motivation may be a factor in determining both student attitudes towards and understanding of evolution. Although this finding is intriguing, the study did not include any data on changes in motivation but rather presented areas for future research. This study offered a small snapshot of the evolution education of college students, however, the small sample size, untested measures, and lack of data on motivation threaten the ability to generalize the results as representing the views of the community college student population in the United States of America.

In another study, Flower (2006) surveyed 342 students in both majors' and nonmajors' biology classes at a community college with regard to their attitude towards evolution and creationism. Of the nonmajor students (n = 242), 58% responded that evolution was scientific and well supported by evidence and 49% acknowledged that species (including humans) evolved from earlier species. A large proportion of the

biology major students (73%) agreed that evolution was well supported by evidence and 57% agreed that all species evolved from earlier species. The results of this study indicate that students who were enrolled in majors' biology courses had a higher rate of acceptance and/or understanding of evolution than those who were enrolled in nonmajors' courses. Interestingly, the evolution rejection rate among the nonmajors' students (41%) closely mirrored that of the United States general public at 42% (The Gallup Poll, 2014). The questionnaire used in this study (as well as the questions used in the McKeachie et al. [2002] study) were not well tested, leaving room for questions in the methodology.

Further research surveyed community college students regarding their understanding of evolution, specifically natural selection, as part of the development of the Conceptual Inventory of Natural Selection (CINS) (Anderson et al., 2002). The CINS is a 20-item measure that has students read three documented evolutionary biology scenarios and answer questions about them. The questions are specifically designed to present students with alternative distractor answers, geared towards assessing whether students truly understand the concept of natural selection.

In its first iteration, the CINS was comprised of four sets of five questions. These questions were then content validated for accuracy by five college biology professors. The authors administered the measure to approximately 100 nonmajor biology students from four community colleges as an ungraded in-class activity. Each group of students completed two of the question sets as a pretest and two question sets as a posttest. The pre- and posttest question groupings were randomly assigned. In addition, the authors

interviewed seven students (each for 20 minutes) from one class about their understanding of natural selection both before and after five hours of lecture and three hours of lab instruction on natural selection. The goals of the interviews were to (a) determine if the CINS accurately represented those students' understanding of natural selection, and (b) assess the readability of the questions and whether the answer choices represented commonly held alterative conceptions.

In the analysis of the original 20 items in first draft of the CINS, five were dropped from the analysis because Anderson et al. (2002) decided the scenario for those questions was too complicated to accurately explain in a limited amount of space. The authors pooled the pre- and posttest data from the remaining 15 items as there were no significant differences between pre- and posttest scores. The results indicated that students averaged approximately 50% accuracy on all three sets of questions (15 items). Despite the somewhat small sample size, the interviews confirmed that those who did well on the CINS also performed well in the interviews (exact data were not provided by the researchers). Anderson et al. noted that students seemed troubled by some of the terminology and that readability may have been an issue for some students. This information led the authors to revise the first draft of the CINS by replacing the problematic scenario with another and revising the wording of some of the questions. In a second field study, the revised CINS was then administered in segments (two scenarios per group) to both major and nonmajor biology students, either before or after instruction on natural selection.

Anderson et al. (2002) used the results of the second field test to select 12 items (from three scenarios) for inclusion in the third draft of the CINS. That resulted in a version that included three scenarios with 20 questions, each with specific distractor answers among the choices. The authors assessed this CINS with 206 community college students in two sections (A and B) of a nonmajor biology class before students had received instruction on natural selection. The mean score on the CINS in section A was 8.21 ± 3.07 and in section B the mean was 10.42 ± 3.31. This difference may be attributable to time constraints as many students in section A did not complete the entire CINS and only two students in section B failed to complete the entire assessment.

Although Anderson et al. (2002) did not conduct the study with the goal of reporting how well community college students understood evolution -- and thus did not focus their analysis on those results -- the mean scores of students indicated they only answered 50% or fewer of the questions correctly.

In the most recent study on community college students this author could find, Brown (2015) completed dissertation research examining the relationships among the acceptance of evolution, understanding of evolution, religiosity (i.e., the degree to which someone is religious, regardless of religion and denomination), and high school experience with evolution and creationism with 373 undergraduate biology students at five community colleges in Texas. Through multiple regression analysis, Brown found that knowledge of evolution weakly explained some of the variance in the acceptance of evolution ($R^2 = 0.198$) and that increasing degrees of religiosity predicted less acceptance of evolution ($R^2 = 0.342$). Although student perception of the amount of focus on

evolution in high school was significantly and positively correlated with the acceptance of evolution, it did not significantly predict acceptance of evolution ($R^2 = 0.004$).

Interestingly, increased religiosity weakly predicted lower knowledge of evolution ($R^2 = 0.078$). Thus, low religiosity was the best predictor of the acceptance of evolution among the students surveyed although it only accounted for 8% of the variance. Furthermore, Brown's research confirmed previous findings that students enter college with a poor understanding of evolution (Moore, Brooks, & Cotner, 2011) as the participants in Brown's study only correctly answered an average of 45.9% questions about evolution.

Brown's (2015) study provides additional insight on community college student understanding and acceptance of evolution, but is somewhat limited because the researcher only surveyed students enrolled in a course for biology majors. Moore et al. (2011) administered a 10-item quiz on evolution (along with two questions about religion and high school biology content with regard to evolution) to 179 students enrolled in their first college biology course. The quiz was administered the week before the course began. Similar to Brown (2015), the authors found that, on average, students were able to answer only 53% of the questions correctly. Using another instrument, Dorner and Sadler (manuscript in preparation) surveyed 166 community college students enrolled in majors and nonmajors biology classes and also found a low level of understanding of evolution: the mean score was 68.8% (although this is higher than previously reported scores).

The mean MATE score was 67.32 (Brown, 2015), which falls within the moderate level of acceptance of evolution. This result is lower than other available

studies in which researchers used the MATE to measure the acceptance of evolution among community college students. Dorner and Scott (2016) surveyed 229 community college students enrolled in majors, nonmajors, and mixed biology courses. They found the average level of acceptance on the MATE to be 81.4 -- within the high acceptance range (Rutledge 1996). A one-way analysis of variance indicated no significant difference in acceptance levels for students enrolled in a majors course, nonmajors course, or mixed course, $F(2, 228) = 2.237$, $p = 0.308$.

There appears to be a limited understanding both of community college student attitudes towards evolution and their understanding of it. Given the range in acceptance and understanding of evolution observed in community college students it is important to conduct further research to clarify this relationship.

Conclusion

There are several factors (e.g., evolution understanding, religiosity, understanding of the nature of science, experience with biology, disposition) that appear to be related to the understanding and acceptance of evolution among college students in the United States of America. There is a limited amount of research, however, on evolution education among community college students. This gap in our knowledge is significant because a large number of people in the country are enrolled in community college and are underrepresented among the literature. This underrepresentation -- especially when combined with the importance of understanding scientific theories when making decisions that affect policy (see introduction) -- justifies future study on the acceptance of evolution among community college students. In addition, few studies specifically have

examined the relationship of acceptance of human evolution to evolution in general. Thus, the desire of this researcher was to examine how the understanding of the NOS and biological evolution and acceptance of human evolution relates to the acceptance of evolution among community college students.

The theory of evolution is considered to be a unifying theme within biology (Dobzhansky, 1973) and central to biology education (American Association for the Advancement of Science [AAAS], 2011). There is, however, debate about how well science education is succeeding in educating students about evolution given that more than 40% of adults in the USA may reject the theory of evolution and believe that the earth was created in the way a literal reading of the Bible suggests (Miller, et al., 2006). Some researchers debate whether the acceptance of evolution -- in addition to understanding the theory -- is one of the goals of science education (e.g., Alters, 1997; Nehm & Schonfeld, 2007). Furthermore, acceptance of evolution may be linked to student understanding of evolution (Cobern, 1994; Meadows, et al., 2000; Scharmann, 1990; Smith, 1994). Understanding the connection between acceptance and understanding of evolution is thus important for determining how to best educate students.

This is not to say that other factors may not play a significant role in the acceptance of evolution. To the contrary, many researchers have examined this issue, exploring the relationship between student acceptance and, for example, teacher understanding (Moore, 2007), psychological constraints (Sinatra, Brem, & Evans, 2008), religious beliefs (Mazur, 2004), affect and motivation (summarized in Sinatra et al.,

2008), demographic factors (Evans, 2000), and prior study in biology and/or in the NOS (Ingram & Nelson, 2006; Rutledge & Mitchell, 2002). Although these factors are all important and worthy of note, the focus of the next chapter is not on the factors themselves but on how I will attempt to measure acceptance and understanding of evolution, understanding of the NOS, and acceptance of human evolution among students.

Chapter 3: Methodology

The purpose of this study was to explore the relationships among and predictive values of the understanding and acceptance of evolution, acceptance of human evolution and understanding of the nature of science (NOS) among community college students. To accomplish this goal, students enrolled in life sciences classes were surveyed at a Southern California community college using a survey instrument that consisted of items selected to address each of these areas. Institutional Review Board approval was received from both Chapman University and the participating community college before beginning the data collection in June 2015.

This chapter explains the development of the survey instrument by detailing the origins of each portion. A description of the participant group and procedures used to gather the data follows. This chapter concludes with an explanation of the data analysis strategies employed.

The Instrument

In this study, I conducted a closed-response, quantitative survey (see Appendix A) developed from four existing instruments. Using a survey -- rather than an interview method -- allowed me to study a larger sample of students. The instrument was rationally derived from existing instruments that addressed each area of concern.

I chose each item from existing instruments to explore different aspects of my research questions. In order to attempt to ascertain student attitudes towards evolution (essential to the primary and secondary research questions addressing the acceptance of evolution), I administered the 20-question Measure of Acceptance of the Theory of

Evolution (MATE) instrument (Rutledge & Warden, 1999) as part of my survey. The MATE was chosen because its reliability and validity have been successfully measured with university students (Rutledge & Sadler, 2007) and high school biology teachers (Rutledge & Warden, 1999), as described below.

Rutledge and Warden (1999) developed the MATE to assess the level of acceptance of evolution among high school biology teachers. The authors' impetus in developing the MATE was a stated need for an instrument that focused more on teacher acceptance than on teacher understanding of evolution. The measure is geared towards examining teachers' perceptions of the ability of evolution to explain phenomena, how well it is accepted in the scientific community, and the theory's scientific validity. The authors composed 20 Likert-scale responses that specifically address different aspects of the acceptance of evolution, including evidence of evolution, human evolution, and evolutionary processes. The measure was balanced among negatively and positively stated items, following the suggestion of Likert (1932), in order to keep the wording straightforward and concise. The Likert scale included the five choices of strongly disagree, disagree, undecided, agree, and strongly agree.

Rutledge and Warden (1999) had the MATE reviewed by five content specialist university professors to assess the content validity and then employed a factor analysis to measure content validity. Because the factor loading values of all items were greater than 0.65 and the single factor model accounted for 71% of item variation, they deemed the MATE valid and sought to establish reliability by sending the measure to 989 high school biology teachers in Indiana to complete. They received a total of 552 completed

instruments. Using Cronbach's alpha, the authors found the MATE internal reliability to be very high at 0.98. Furthermore, upon completion of item analysis, each item correlated at greater than $r = 0.65$, which indicated that each item added to instrument reliability. Scores range from a low of 20 (low level of acceptance) to a high of 100 (high level of acceptance). Rutledge (1996) previously established categories of acceptance of evolution based on specific MATE scores: very low (20-52), low (53-64), moderate (65-76), high (77-88), and very high (89-100).

Rutledge and Warden (1999) asserted that, based on the high degree of internal validity, a major strength of the MATE is that it "is homogenous, assessing a single construct, which allows for clear interpretation of the results generated from its administration" (p. 16). One of their concerns was whether the MATE could be reliably used in other populations. In a later study, Rutledge and Sadler (2007) set out to establish the temporal reliability of the MATE instrument with university students. To accomplish this goal, the authors administered the MATE to nonmajors biology students in a midsize university in the South. The authors sought to establish reliability in part through the test-retest method. Of the 61 students who completed both the test and retest, the majority of students were in their first year (55%), 31% were sophomores, and the remaining 12% were juniors and seniors. The instructors of the course did not engage in any discussion of the NOS or evolutionary biology in the three-week interval between the test and retest. The results indicated a strong positive correlation (Pearson correlation = 0.92) (Rutledge & Sadler, 2007). Rutledge and Sadler (2007) found a Cronbach's alpha of 0.94, which is similar to the earlier Rutledge and Warden (1999) study. These results indicate strong

internal consistency. Thus, the MATE is appropriate for use among university students, either on its own or with additional instrumentation.

In order to explore acceptance of human evolution (a secondary research question), I used a portion of the Inventory of Student Evolution Acceptance (I-SEA) measure which is specifically focused on human evolution (Nadelson & Southerland, 2012). The I-SEA is a 21-question, Likert-scale measure. I specifically chose eight questions about human evolution for this measure. Although I could find no studies either validating or criticizing the measure, its initial development and analysis revealed a high level of internal consistency (Cronbach's alpha = 0.95, Nadelson & Southerland, 2012) and it was recommended as a way to assess the acceptance of human evolution (Southerland & Nadelson, 2012), in concert with the MATE.

To account for differences in acceptance of microevolution, macroevolution, and human evolution, Nadelson and Southerland (2012) developed the I-SEA. These authors set out to measure the attitudes of students towards evolution by generating Likert-type scale questions. They developed items for each of three subscale areas: microevolution, macroevolution, and human evolution. One of the goals of this measure was to examine both the acceptance of a specific evolutionary construct and the acceptance of the evidence for that construct. The items in the survey were distributed nearly equally across the three subscales and evenly across items dealing with constructs versus evidence of those constructs.

Nadelson and Southerland (2012) included a total of eight items in each subscale with the following breakdown: five questions evaluating acceptance to the construct itself

and three items assessing the acceptance of the evidence supporting that construct. They administered the revised 24-question I-SEA to 397 college students and 404 high school students. As 60 high school students were in their first year, they would not yet have had high school biology. Because they lacked formal education on evolution, they were excluded for a final sample size of 344. Statistical analyses of the revised I-SEA revealed a Cronbach's alpha of 0.95 overall, 0.90 for the macroevolution subscale, 0.90 for the microevolution subscale, and 0.94 for the human evolution subscale, indicating a high level of internal consistency within the entire measure and the three subscales.

The overarching goals in developing the I-SEA were to widen the variety of instruments for measuring evolution and to be able to capture the differences in acceptance of distinctive components of evolution (Nadelson & Southerland, 2012). Nadelson and Southerland (2012) contended that they achieved these goals, which is significant because other researchers have reported that micro- and macroevolution are often viewed differently by people (Alters & Alters, 2001; Scott, 2004). Given the high level of internal consistency within the human evolution subscale (as evidenced both by the expert reviewers' validation of the content and the high level of reliability), I chose to use these items separate from the rest of the I-SEA for my instrument.

To assess understanding of the NOS, I used questions from the Evolutionary Attitudes and Literacy Survey Short Form (EALS-SF) (Short & Hawley, 2012). Although the understanding of the NOS can arguably be better assessed through open-ended instruments, as Carter and Wiles (2014) noted, this method is not conducive to large-sample-size quantitative data. Previous researchers suggest that longer surveys can result

in lower response rates due to participant fatigue (Bogen, 1996; Porter, 2004). Thus, in an effort to avoid participant fatigue, I chose a few specific items to assess the most basic understanding of the NOS. The EALS-SF was developed from the original, longer EALS (Hawley et al., 2011). It has been well validated through confirmatory factor analysis (Hawley et al., 2011) and used to assess several factors, including knowledge of evolution, attitude toward evolutionary theory, political and spiritual views, and knowledge about the scientific enterprise. Each of the constructs they measured had a Cronbach's alpha between 0.57 and 0.95 and the construct of the items that I extracted had a Chronbach's alpha of 0.78 (Hawley et al., 2011) which is adequate for research purposes.

The long form consists of 104 statements, to which students respond using Likert-scale statements and the short form has 62 items. Both the long and short forms were designed to measure 16 constructs, including political activity, evolutionary misconceptions, and knowledge about the scientific enterprise. Whereas the EALS-SF assesses many factors relating to the acceptance of evolution and literacy, I specifically chose the four items that delve into understanding the basic NOS and understanding the scientific enterprise. Whereas the EALS-SF relies on a seven-point Likert scale, I used a five-point Likert scale to maintain consistency across all of the items in my survey instruments, so as to avoid participant misunderstanding.

Finally, to determine participants' level of understanding of evolution, I used items from the 5-8 Life Sciences Concept Inventory (LSCI) pool (Sadler et al., 2013) that are specifically designed to measure knowledge about various aspects of evolution.

Sadler et al. (2013) constructed a distractor-driven multiple-choice test to assess eighth grade student understandings of specific science standards. They focused this test on fifth- through eighth-grade level standards and tested the questions nationally with more than 30,000 students.

In 1996, the National Research Council (NRC) developed National Science Education Standards that have been implemented -- in some form or another -- in all 50 states (Sadler et al., 2013). Standard 5, on diversity and adaptation of organisms, focuses on the diversity of life on the planet, evolution as the explanation for diversity, and extinction. These LSCI items have been well validated in younger populations. By using questions based on science standards to which students should have been exposed earlier in their education, I was able to measure a basic understanding of evolution.

It is important to note that these items were developed by Sadler et al. (2013) at Harvard University at great expense and can thus only be used following strict security protocols. In order to secure the LSCI authors' agreement to include these items in the survey, electronic copies of the secure items can only be accessed in the dissertation committee chair's office. As such, the instrument included in this dissertation does not include secure items that will be used on the final version of the dissertation survey. Instead, it includes four items, available for public use, that are representative of the 10 items I actually included on the finalized survey.

The 10 LSCI items were chosen based on a previous study that examined evolution understanding among community college students (Dorner & Sadler, manuscript in preparation). The authors administered the 41 items of the LSCI that relate

to the science standards on evolution to a group of 166 community college students enrolled in life sciences classes. Of those 41 items, there were 10 items that at least 40% of the students answered incorrectly. I chose to use those 10 items on this dissertation research to avoid underestimating the understanding of evolution by asking questions that were too easy for college students.

I also added three questions to determine (1) in which course the student was enrolled, (2) how many college biology classes students had previously taken, and (3) how many college science classes students had previously taken. An additional question addressed whether the students were aiming for a career in life science, related to life science, in a non-life science, outside of the sciences, or not sure. Students reported their sex, ethnicity, and age in three final questions.

Thus, the study included in order: four EALS-SF items, 20 MATE items, eight I-SEA items, 10 secure items from the 5-8 LSCI, three science course experience questions, one career question, and three demographics questions, for a total of 49 items. I began the instrument with the EALS-SF NOS items so as to avoid potentially biasing those responses by having them follow the evolution questions, however it is possible the composition of the measure could have resulted in unforeseen order effects. The instrument concluded with the 5-8 LSCI questions, science experience and career questions, and the demographic questions as they are multiple choice questions and not on a Likert scale (the rest of the questions are Likert scale-based). Ending with those questions allowed me to include separate instructions for answering multiple choice questions.

To score the questions appropriately, I used the following system:

- for questions 1-33, a score of strongly disagree = one point, disagree = two points, undecided = three points, agree = four points, and strongly agree = five points;
- the following items were reverse coded to accurately calculate a score using the scale above: 2, 3, 6, 8, 10, 11, 13, 14, 18, 19, 21, 23, 26, 27, 30;
- for the multiple choice LSCI items, each item was worth one point for the correct answer, zero points for the incorrect answer and correct answers are: a, b, a, b (*for security reasons, these are not the actual items used in the survey but are representative of the survey items).

Although the survey overall is limited to face validity, I attempted to further validate the instrument by having a pilot group of 36 students complete the survey and report on its readability (there were no issues with readability). In addition, two content experts (in science and evolution education) reviewed the survey for its content accuracy and I calculated Cronbach's alphas for each scale. For the MATE and I-SEA items, the Cronbach's alphas (0.932 and 0.911) indicate these are reliably representing the participants' views of the underlying concept given an alpha of ≥ 0.7 is the generally accepted cutoff for reliability (Kline, 2005). The reliability of the LSCI scale fell just below that point ($\alpha = 0.657$) and the EALS-SF items had a low alpha of 0.444. Given the small number of items in this group (only four items), it is recommended to report the mean inter-item correlation, which was 0.153 (Pallant, 2013). This mean also falls outside the optimal range for inter-item correlation of 0.2 - 0.4 (Briggs & Cheek, 1986). I discuss this lack of internal reliability in the limitations section of Chapter 5.

Procedure and Participants

I surveyed 978 English-speaking, adult students who were enrolled in life sciences courses at one community college in Southern California. The school is mid-size, with approximately 14,000 students enrolled (Facts & Figures, 2015). The study was conducted through in-person class visits in which students were provided with consent information (see Appendix B). Data were collected in the first two weeks of the summer courses (June, 2015) or the first three weeks of the fall courses (August-September, 2015). The data collection timing was chosen because most courses cover evolution in more detail in the second half of the semester. By surveying students in the first couple weeks of class, I was more likely to measure the knowledge and attitudes students possessed upon entering the course rather than what they thought after being presented with the course material.

I contacted 38 life sciences faculty via email to ask for their participation. Fourteen faculty responded and then suggested a class period at the convenience of the faulty member teaching it. In total, I surveyed 51 classes across 16 different courses (multiple sections of some courses). A description of the number and distribution of courses surveyed, as well as the timing of the surveys, can be seen in Table 3.1. In Table 3.1, the names of the courses have been changed to protect the anonymity of the school and the new names accurately reflect the course content. Completing the survey took students less than 30 minutes, and students were only required to do so once. No identifiable data were collected from any participant, and participation was voluntary. Additionally, students could choose not to complete the survey once they had begun it.

Participants received no compensation or course credit in return for their participation, nor was there any penalty if they chose not to participate.

Table 3.1:

Summary of the Course Sections Surveyed

Course name (names have been changed but accurately reflect content)	Course typically taken by life sciences majors, nonmajors or a mix	Number of sections surveyed in summer	Number of sections surveyed in fall	Total number of sections surveyed
Biotechnology	nonmajor		1	1
Biology and Humans	nonmajor		1	1
Animal Behavior	nonmajor		1	1
Ecology	mix		1	1
Principles of Biology	mix	4	5	9
Principles of Biology Lab	mix	3	10	13
General Biology 1	major	2	2	4
General Biology 2	major		4	4
Botany	major	1		1
Biochemistry	major	1		1
Human Anatomy	major	2	5	7
Human Physiology	major	1	2	3
Microbiology	major		2	2
Anatomy and Physiology	major		1	1
Molecular Biology	major		1	1
Genetics	major		1	1

Data Collection and Treatment

Data were collected using bubble forms, allowing for automated data entry. The forms contained no identifiable data and were sent via FedEx to Harvard University for scanning. Data were entered into Excel and analyzed to determine how many of the surveys were missing answers to one or more questions. Of the 978 surveys, 111 were

missing one or more answers. As the sample size was large -- and to avoid the possibility of introducing unknown errors into the sample -- I chose not to use multiple imputation and instead excluded the 111 cases from data analysis. Multiple imputation is a statistical technique that calculates estimated for missing data based on existing patterns in the available data, which can allow the missing cases to be included in the overall analysis (Tabachnik & Fidell, 2013).

All computer files of data and data analysis were stored on a password-protected computer in the home of the researcher. Questions were reverse coded to account for negatively worded questions. For example, in this straightforward statement, ‘evolution is a scientifically valid theory,’ scoring would be as follows: ‘strongly agree’ = 5 points whereas ‘strongly disagree’ = 1 point. In a negatively worded statement, e.g., ‘evolution in not a scientifically valid theory’ scores would need to be reverse coded, i.e., ‘strongly agree’ is a score of 1 whereas ‘strongly disagree’ is a score of 5. Additionally, score totals were calculated for the EALS-SF questions (out of a possible 20 points), the MATE (out of a possible 100 points), the I-SEA questions (out of a possible 40 points), and the LSCI (out of a possible 10 points). The data were then imported into SPSS for analysis.

In order to describe the overall make-up of the population with regard to the acceptance of evolution and understanding, as well as understanding of the NOS, I analyzed survey data by calculating standard central tendency measures (mean, standard deviations) for each construct. In characterizing the acceptance of evolution using the MATE, I followed established categories of acceptance of evolution based on specific

MATE scores: very low (20-52), low (53-64), moderate (65-76), high (77-88), very high (89-100) (Rutledge, 1996).

I then conducted statistical analyses to determine whether there were any relationships among the level of acceptance of evolution and other factors (e.g., understanding of natural selection and the NOS, and acceptance of human evolution). Specifically, I conducted a *t*-test to compare the MATE means between summer and fall to determine whether the data could be pooled. I also conducted Pearson Product Moment correlation coefficients, partial correlations, and multiple regressions to explore relationships between the variables. The results are presented in the next chapter.

Chapter 4: Results

This study was an exploration of the relationships among the acceptance of evolution, understanding of evolution, understanding of the nature of science (NOS), and the acceptance of human evolution of community college students. To assess these relationships, community college students completed an anonymous survey with the following components:

- Four Likert-scaled questions about understanding the NOS with scores ranging from 5 to 20 (higher score indicates better understanding of the NOS);
- 20 Likert-scaled questions addressing acceptance of evolution, with scores ranging from 20 to100 (higher score indicates higher acceptance of evolution);
- Eight Likert-scaled questions examining acceptance of human evolution, with scores ranging from 8 to 40 (higher score indicates higher acceptance of human evolution);
- Ten multiple choice questions assessing the understanding of evolution, with scores ranging from 0 to 10 (higher score indicates better understanding of evolution); and
- Four questions regarding student career goals and previous experience with science courses, and three demographic questions (i.e., sex, ethnicity, and age).

In this chapter I describe the results of this research. The chapter begins with a description of the participants and follows with an explanation of how the data were analyzed and the rationale for the analyses. I then address the research questions laid out in Chapter 1 and conclude by discussing a post hoc analysis with regard to the

relationships among the acceptance of human evolution, understanding of evolution, and understanding of the NOS.

Characteristics of the Participants

In total, 978 students participated in the survey. However, 111 surveys were not used in this data analysis as they were missing answers to one or more questions on the survey. Of the remaining 867 surveys, 31.1% (n = 270) were gathered in the summer of 2015 and 68.9% (n = 597) were gathered in the fall of 2015. These data were pooled after no significant difference was found in an independent samples *t*-test between the scores on the MATE in summer (77.62 ± 13.94) and fall (77.18 ± 13.55) ($t = 0.435$, $p = 0.664$). The data analysis that follows considers all 867 cases.

Of the 867 students whose surveys are included in this analysis, 40.8% were enrolled in courses for life sciences majors, 48.1% were enrolled in courses made up of a mix of major and nonmajors students, and the remaining 11.1% were enrolled in strictly nonmajors courses. Of the students, 42.1% were enrolled in their first college biology course, 27.9% had taken one course previously, 12.9% had completed three courses, 4.7% had taken four courses, and 12.3% had taken five or more college-level biology courses. In terms of experience with college-level science courses, 22.6% of students were enrolled in their first college science course, 18.8% had taken one course previously, 16.3% had completed three courses, 8.7% had taken four courses, and 33.7% had taken five or more college-level science courses. Many of the students surveyed reported hoping to have a career in a life science field (30.2%), whereas 11.6% wanted a

career specifically in biology, 19.1% sought a career in an unrelated science, 24.6% envisioned a career outside of the sciences, and 14.4% were undecided.

Demographically, the population surveyed was comprised of more males (54%) than females and identified largely at White/European American (30.3%) and Asian American (33.1%). The remainder of the group was Black/African American (20.1%), Hispanic/Latino (21.6%), and 12.9% identified as “Other.” The majority of students (66.2%) reported their age as being between 18 and 21 years of age, whereas 26.2% were 22-29, 5.5% were 30-39, 1.5% were 40-49, and 0.6% were 50 years of age or older.

Assessing the Normality of the MATE Distribution

In order to assess the appropriateness of employing different statistical analyses it is important to assess the normality of the data and discuss how the data meet the assumptions of each technique. A discussion of the normality of the data follows and an examination of the assumptions of each technique is included in the following sections of the results.

The mean, median, and standard deviations of the scores of each scale are presented below in Table 4.1. Scores are also listed in Table 4.1 in the form of a percentage of the mean score out of the total possible score for easier comparison. The mean score on the MATE was 77.32, which falls within the range of high acceptance of evolution (Rutledge, 1996). The mean score of the acceptance of human evolution (I-SEA) was 29.60, which is similar to the general acceptance of evolution score derived from the MATE, as seen in the percentages of the response scores (77.32% versus 74%). On average, students answered only half of the questions about evolution correctly (based

on the mean score of 5.05 out of a possible 10 points on the LSCI questions), although their understanding of the NOS was relatively higher (based on the mean score of 15.93 out of a possible 20 points EALS-SF scale).

Table 4.1
Means, Standard Deviations, and Medians for Measures of the Acceptance and Understanding of Evolution, Understanding of the NOS, and the Acceptance of Human Evolution.

Score	Mean (total possible score)	Standard deviation	Median	Percentage of total score
MATE	77.32 (100)	13.667	78	77.3%
LSCI	5.05 (10)	2.45	5	50.1%
EALS-SF	15.93 (20)	2.542	16	79.7%
I-SEA	29.60 (40)	7.186	31	74.0%

The scores on the MATE are displayed below in Figure 4.1. Skewness (the symmetry of the distribution of the scores) and kurtosis (the shape of the distribution in terms of its peakedness) of the MATE scores (skewness = -0.4448, kurtosis = -0.093) fall within the acceptable range of normality, which is ± 1 or ± 2 (Pallant, 2013). Although a Kolmogorov Smirnoff test (which tests for normality of the data) indicated that the MATE (statistic = 0.48, $p < 0.001$) score distribution violates normality, this is common in data sets with a large sample size (Pallant, 2013).

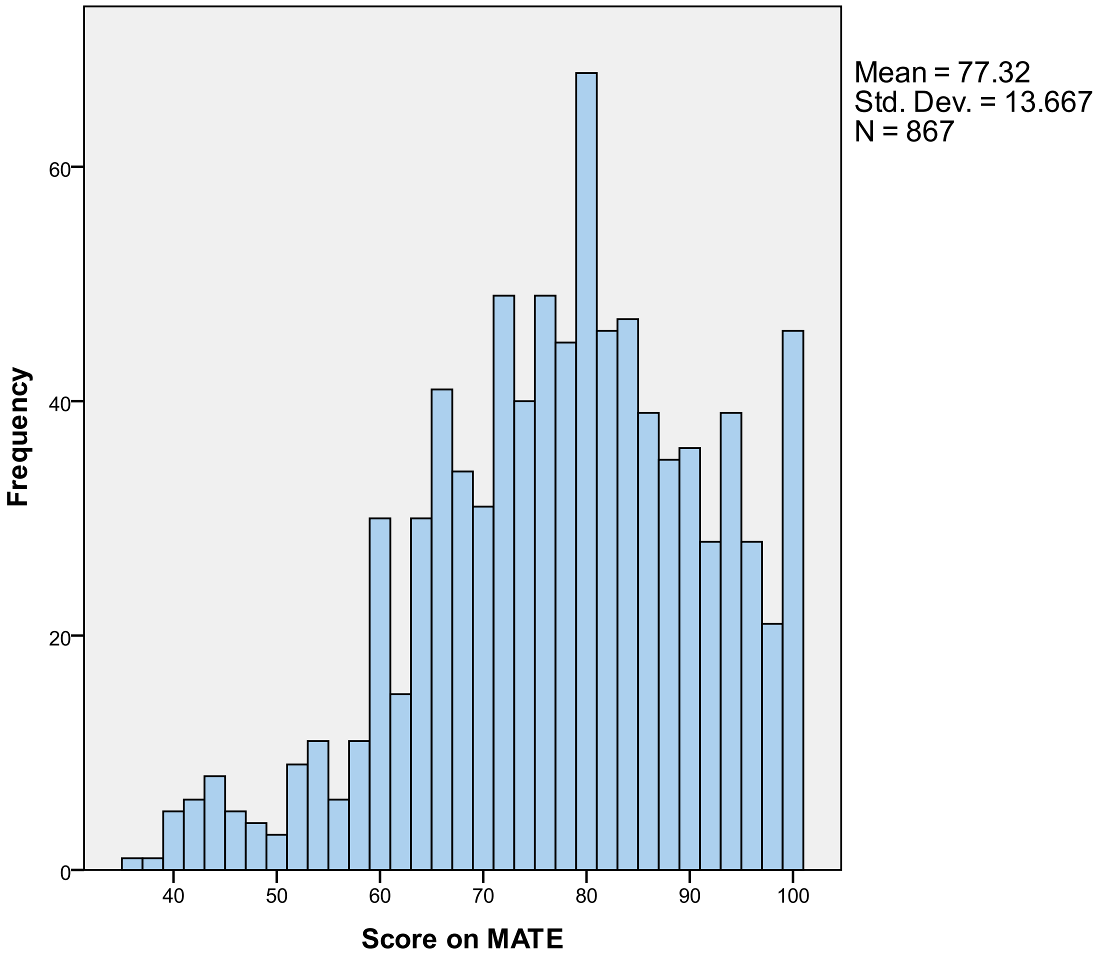

Figure 4.1: Histogram of MATE Scores

Data Analysis Description and Rationale

There are several underlying assumptions of parametric statistics: normality of the data, large sample size, independence of observations, apparent linearity, and homoscedasticity ("the variance of the residuals about predicted DV [dependent variable] scores should be the same for all predicted scores" [Pallant, 2013, p. 157]) (Pallant, 2013). The current data set meets those assumptions acceptably and thus the data were analyzed using two parametric statistics: the Pearson product-moment correlation and

multiple regression. One additional assumption of these statistical tests may be problematic: they are designed to be used with continuous variables. In this study, the MATE, I-SEA, and EALS-SF scores are ordinal measures as they are based on Likert scales. However, it is acceptable to analyze them as continuous variables, based on intervals (although not necessarily equal intervals) (Norman, 2010). The LSCI score is a continuous variable, as are two of the four questions about student experience with science courses (the number of college science courses they have taken and the number of college biology courses they have taken).

Data from the other two science course experience questions were recoded to fit the assumptions of these analyses. Data from the question addressing student future educational goals (whether they chose a career in biology, life science-related field, other science, non-science, or were undecided) were "dummy coded" (Stockburger, 2001) into separate dichotomous independent variables. Data from the question addressing in which class the student was currently enrolled were recoded into three categories based on the target audience of those courses: biology majors, nonmajors, and a mix of both. Because only 11.1% of the surveys were from students enrolled in strictly nonmajors classes -- and most of the students enrolled in the mixed classes were nonmajors -- the nonmajors and mixed class students were pooled to make a dichotomous independent variable of 'major' or 'mixed.'

Among the demographic variables, sex was treated as dichotomous (male, female) and ethnicity was dummy coded into the following dichotomous variables: White/European vs. non-White/European, Black/African American vs. non-

Black/African American, Hispanic/Latino vs. non-Hispanic/Latino, Asian American vs. non-Asian American, and other vs. not. Finally, even though age is broken down into specific intervals (based on the way in which the school records the ages: 18-21, 22-29, 30-39, 40-49, and 50 and older), age was treated as a continuous variable. Additional assumptions of the multiple regression analysis are discussed with the presentation of those results below.

Correlations Among Variables

To address the secondary research questions regarding the existence and nature of a relationship between the level of acceptance of evolution and the level of acceptance of human evolution, understanding of the NOS, and understanding of evolution, Pearson product-moment correlations were conducted. Table 4.2 (below) displays the correlation results between each of the measured scales. Each correlation is significant at the $p >$ 0.01 level. Characterizing the strength of the correlation is based on guidelines laid out by Cohen (1988): r = 0.1- 0.29 is a small correlation, r = 0.3 - 0.49 is medium, and r = 0.5 - 1.0 is large.

Table 4.2

Pearson Product-Moment Correlation Coefficients

	MATE Score	I-SEA Score	EALS-SF Score	LSCI Score
MATE Score	-	0.812	0.497	0.536
I-SEA Score	-	-	0.358	0.408
EALS-SF Score	-	-	-	0.378
LSCI Score	-	-	-	-

These results indicate that acceptance of evolution was strongly correlated with acceptance of human evolution (0.812). The acceptance of evolution was also strongly

correlated with understanding of evolution (0.536) and moderately correlated with understanding of the NOS (0.497). Understanding of the NOS was also moderately correlated with the understanding of evolution (0.378).

Interestingly (as it is outside the scope of the initial research questions), the acceptance of human evolution was moderately correlated with understanding of the NOS (0.358) but less so than was the acceptance of evolution in general (0.497). The same outcome is true for the relationship between the acceptance of human evolution and the understanding of evolution (0.408). I explore this more fully in the "Post Hoc Analysis" section.

Multiple Regression Analyses

Based on the strength of the correlation results, it was necessary to examine interactions between the variables to assess the overarching primary research question: To what extent does a relationship exist between the acceptance or rejection of biological evolution by community college students and selected academic science-oriented factors (i.e., how well they understand evolution and the NOS)? Employing a multiple regression analysis allowed me to examine relationships among all of the scales and their predictive values. This technique also allowed me to determine whether other variables (educational goals, science course experience, and demographics) were correlated with the acceptance of evolution.

As stated above, the data set meets most of the assumptions of the multiple regression, with some exceptions in addition to the previous discussion of continuous variables. Multiple regression is very sensitive to outliers. However, the MATE scores

display very few outliers, indicating this was not an issue (Pallant, 2013). Multiple regression also requires independence of residuals, which this data set demonstrated (Cook's distances reported below). Multiple regression is also susceptible to multicollinearity, which occurs when independent variables are highly correlated ($r \leq 0.9$) (Pallant, 2013). Although the correlation between the score on the I-SEA and the MATE (that acceptance of human evolution and acceptance of evolution are positively correlated) falls below that threshold (0.812), given its strength, multiple regression analyses were conducted in the following ways to assess the potential multicollinearity:

1. One regression to predict MATE scores including the I-SEA score as an independent variable.
2. A separate regression to predict MATE scores that excluded I-SEA as an independent variable.

The first multiple regression with the MATE score as the dependent variable and all other variables as independent variables revealed no other significant correlations between variables other than those discussed above. Specifically, age, ethnicity, number of science courses taken, number of biology courses taken, current class as a major or mixed class, and educational/career goal were not significantly correlated with the MATE, EALS-SF, I-SEA or LSCI scores (for all variables, $r \leq 0.125$) (see Appendix C).

The multiple regression indicated a R^2 of 0.743 and the adjusted $R^2 = 0.739$ (ANOVA significance < 0.001). This finding indicated that these variables accounted for nearly 75% of the variation in the MATE scores (the acceptance of evolution). Of that 75% variation, the Beta and partial coefficients listed in Table 4.3 below indicate that the

I-SEA score accounts for the majority of the variability in the MATE score (75.7%), although understanding of the NOS and evolution account for some of the variation as well (28% and 31%). Additionally, VIF values (the inverse of the tolerance values that indicate how much variability in the independent variables is not explained by other independent variables) and collinearity values indicate that the data meet the assumptions of multiple regression (Pallant, 2013). As the maximum Cook's distance (0.033) falls below one (Tabachnik & Fidell, 2013), outliers appear not to have a significant impact on the analysis.

Table 4.3

Regression Analysis among MATE Scores and All Other Variables

Variable	Standardized Beta coefficient	Partial correlation coefficient
I-SEA Score	0.666	0.757
EALS-SF Score	0.172	0.289
LSCI Score	0.193	0.312
All other variables	< 0.06	< 0.09

The second multiple regression analysis with the MATE score as the dependent variable and all other variables as independent variables, except the I-SEA score (excluded), indicated the other variables had weaker predictive value (see Appendix D for full results). The analysis revealed a R^2= 0.399 and an adjusted R^2 = 0.390 (ANOVA significance < 0.001). In essence, these variables accounted for 39% of the variation in the MATE scores, much less than if the acceptance of human evolution variable were included (75%). The Beta and partial coefficients listed in Table 4.4 indicate that once the I-SEA was excluded, the LSCI score (evolution understanding) accounted for the majority of the variability in the MATE score (43.3%), although understanding of the

NOS accounted for some of the variation as well (36.4%). Collinearity and VIF values indicate that the data meet the assumptions of multiple regression (Pallant, 2013) and the maximum Cook's distance (0.023) falls below one (Tabachnik & Fidell, 2013) indicating outliers did not impact the analysis.

Table 4.4

Regression Analysis among MATE Scores and All Other Variables Excluding the I-SEA Scores

Variable	Standardized Beta coefficient	Partial correlation coefficient
EALS-SF score	0.332	0.364
LSCI score	0.409	0.433
All other variables	< 0.07	< 0.08

Post Hoc Analyses

Although examining the relationships among the acceptance of human evolution and academic factors such as NOS understanding and understanding of evolution was not part of the initial research proposal, it was deemed appropriate to delve into this relationship more fully given the strong relationship between the acceptance of evolution and human evolution. In addition, given the moderate correlation between the acceptance of human evolution, the understanding of the NOS (0.358), and the understanding of evolution (0.408), the relationship warranted further examination.

The skewness and kurtosis for the I-SEA scores (skewness = -0.678, kurtosis = 0.055) fell within the acceptable range of normality (± 1 or ± 2) (Pallant, 2013). A Kolmogorov Smirnoff test indicated the I-SEA (statistic = 0.94, $p < 0.001$) score

distributions violate normality, which is common in data sets with a large sample size (Pallant, 2013). The I-SEA scores are displayed in Figure 4.2.

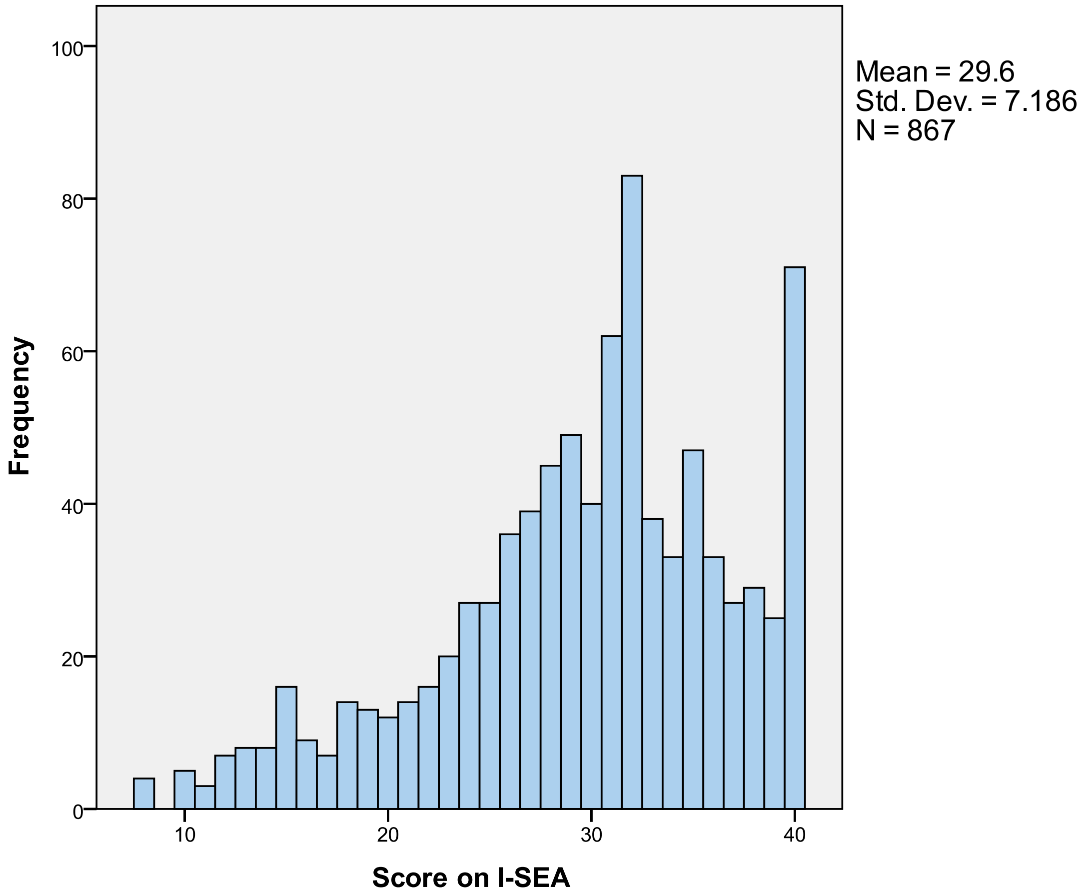

Figure 4.2: Histogram of I-SEA Scores

The I-SEA data set meets most of the assumptions of multiple regression (although it is skewed towards high scores), including the fact that the I-SEA scores display very few outliers, indicating this is not an issue (Pallant, 2013). As previously discussed, multiple regression requires independence of residuals (Cook's distances reported below), and is susceptible to multicollinearity. The correlation between the

scores on the I-SEA and the MATE is high, so multiple regression analyses were conducted in the following ways to assess potential multicollinearity:

1. One regression to predict I-SEA scores, including the MATE score as an independent variable.
2. A separate regression to predict I-SEA scores that excluded MATE as an independent variable.

The first regression analysis with the I-SEA score as the dependent variable and all other variables as independent variables indicated that acceptance of evolution (the MATE) accounted for the majority of the variance in the I-SEA scores (75.7%). Beta and partial coefficients listed in Table 4.5 below support the above assertion, although understanding of NOS and evolution accounted for some of the variation as well. In this regression, R^2= 0.66 and the adjusted R^2 = 0.664 (ANOVA significance < 0.001), which indicate that these variables accounted for nearly 67% of the variation in the I-SEA scores (see Appendix E for full results). Additionally, VIF values and collinearity values indicated that the data meet the assumptions of multiple regression (Pallant, 2013). The maximum Cook's distance (0.028) fell below one (Tabachnik & Fidell, 2013) so outliers appear not to have had a significant impact on the analysis.

Table 4.5

Regression Analysis among I-SEA Scores and All Other Variables

Variable	Standardized Beta coefficient	Partial correlation coefficient
MATE score	0.860	0.757
EALS-SF score	-0.046	-0.068
LSCI score	-0.027	-0.039
All other variables	< 0.06	< 0.08

The second regression analysis with the I-SEA score as the dependent variable and all other variables as independent variables, except the MATE (excluded) revealed that evolution understanding accounts for the majority of the variance in the I-SEA scores. However, the model is somewhat weak. The multiple regression analysis revealed that $R^2 = 0.22$ and the adjusted $R^2 = 0.214$ (ANOVA significance < 0.001). These variables accounted for only 22% of the variation in the I-SEA scores (the acceptance of human evolution) and within that 22%, the Beta and partial coefficients listed in Table 4.6, indicated that the LSCI score (evolution understanding) accounted for the majority of the variability in the I-SEA score, although understanding of the NOS and evolution accounted for some of the variation as well (see Appendix F for full results). The maximum Cook's distance (0.027) fell below one (Tabachnik & Fidell, 2013), so outliers appear not to have had a significant impact on the analysis and VIF values and collinearity values indicated that the data met the assumptions of multiple regression (Pallant, 2013).

Table 4.6

Regression Analysis among I-SEA Scores with All Variables Excluding the MATE Scores

Variable	Standardized Beta Coefficient	Partial Correlation Coefficient
EALS-SF score	0.239	0.241
LSCI score	0.324	0.318
All other variables	<0.07	<0.06

Conclusion

Results indicate that the community college students surveyed have a poor understanding of evolution, a relatively better understanding of the NOS, a high acceptance of evolution, and a moderate acceptance of human evolution. The acceptance of evolution in general and human evolution are highly correlated but when that relationship is excluded, understanding of evolution is the best predictor of acceptance of evolution. The next chapter will discuss the implications of the results, limitations of this study, and opportunities for future research.

Chapter 5: Discussion

This dissertation was an examination of the acceptance of evolution among community college students enrolled in life sciences classes. In this chapter, I summarize the study and discuss the implications of the results. Specifically, I compare the results of of my research to the current literature, discuss the limitations of my research, and provide suggestions for future research. I conclude with a call to action for science educators.

Summary of the Study

The goal of this study was to explore the relationships among and predictive values of selected academic factors and the acceptance of evolution among community college students. To achieve this goal, 978 students were surveyed regarding their attitudes towards evolution and human evolution, their understanding of the nature of science (NOS) and evolution, their experience with college-level biology and science course, career goals, and basic demographic variables. In the first few weeks of school, students completed the 20-item MATE (Rutledge & Warden, 1999) and an eight-question portion of the I-SEA (Nadelson & Southerland, 2012) to measure attitudes towards evolution and human evolution respectively. To assess understanding of the NOS and evolution, students answered four questions from the EALS-SF (Short & Hawley, 2012) and 10 questions from the LSCI (Sadler et al., 2013). Students also reported in which course they were enrolled, how much experience they had with college biology and science classes, if they had career goals in life sciences, and demographic characteristics (e.g., sex, age, and ethnicity).

Of the 978 surveys, 867 were completed fully and were included in the data analysis. I calculated score totals for each scale of the instrument and used the Pearson product-moment correlation to explore the relationship among each of the scales. In addition, multiple regression analyses were employed to further examine relationships among the variables to predict and explain the variation in the acceptance of evolution and human evolution scores.

Summary of the Results

The MATE mean score was 77.32 (out of 100), which qualifies as high acceptance of evolution (Rutledge, 1996). The mean score for the acceptance of human evolution (on the I-SEA) was 29.6 (out of 40), which is relatively lower than the acceptance of evolution in general. The mean score on the LSCI items was 5.05 (out of 10), indicating the students had a poor understanding of evolution. Furthermore, the mean score on the EALS-SF was 15.93 (out of 20), indicating the students had a relatively better understanding of the NOS than of evolution.

The acceptance of evolution was significantly and positively correlated with each of the other scales and was most highly correlated with the acceptance of human evolution (r = 0.812), largely correlated with understanding evolution (r = 0.536), and moderately correlated with understanding of the NOS (r = 0.497). The acceptance of human evolution followed the same pattern, but showed only moderate correlations with understanding of the NOS (r = 0.358) and understanding of evolution (r = 0.408). Understanding of the NOS was moderately correlated with understanding of evolution (r = 0.378).

A multiple regression analysis indicated that the factors measured accounted for nearly 75% of the variance in the MATE scores, with the majority of that variance (75.7%) being attributed to the acceptance of human evolution. Understanding of the NOS accounted for 28.9% of the variance and understanding evolution explained 31.2% of the variance. When the acceptance of human evolution was removed, the understanding of evolution had the highest explanatory value, accounting for 43% of the variance whereas understanding of the NOS accounted for 36.4% of the variance. In both analyses, experience with college biology and science courses, career goals, course enrollment, and demographics variables were not significant in explaining the variance in the MATE scores.

Unsurprisingly, in a post hoc analysis, a multiple regression analysis indicated that 66.4% of the variance in the acceptance of human evolution was explained by the other factors measured and acceptance of evolution accounted for most of that variance (75.7%). When the acceptance of evolution was excluded from analysis, the multiple regression indicated that the others factors only explained 22% of the variation in the acceptance of human evolution and, of that 22%, understanding of evolution explained 31.8% and understanding of the NOS explained 24.1% of the variance.

Implications

In this section, I compare the results of this dissertation with the existing literature. I begin by exploring how the scores on the acceptance of evolution, evolution understanding, understanding of the NOS, and the acceptance of human evolution link

with previously reported data. I conclude with a discussion of the importance of the relationships among these variables and how they relate to other studies.

The Acceptance of Evolution

With an average score of 77.32 on the MATE, students in this study exhibited a high level of acceptance of evolution (Rutledge, 1996). This level of acceptance of evolution is in the middle of the range of scores that have been previously reported among college students. With community college students, Brown (2015) used the same instrument and found acceptance levels of 67.32, which falls in a lower category of moderate acceptance (Rutledge, 1996), whereas Dorner and Scott (2016) found average MATE scores of 81.4 (a high level of acceptance). Using another measure, Flower (2006) found low acceptance levels of evolution of 39% among nonmajors students, versus 57% acceptance among biology majors. In the university setting, levels of acceptance range from a mean score on the MATE of 55.87 in nonmajors biology students, which qualifies as low acceptance (Rutledge & Sadler, 2007), to 60% of majors biology students accepting evolution at a high or very high level when assessed using the MATE (Carter & Wiles, 2014). The levels of acceptance in the college setting represent a wide range however, are higher than those found in the general public (The Gallup Poll, 2014).

Evolution Understanding

In reference to the secondary research questions, this dissertation explored relationships among the acceptance of evolution and understanding, understanding of the NOS, and the acceptance of human evolution. Students in this study had a poor understanding of evolution, answering questions correctly only 50.5% of the time. These

results align well with previous studies that have used a different measure, in which scores ranged from 45.95% among community college biology majors students (Brown, 2015) to 54% and 53% among university introductory biology students (Moore et al., 2011; Moore et al., 2009). Additionally, when a third measure was employed (The Conceptual Inventory of Natural Selection), university nonmajors biology students scored at 50% or less (Anderson et al., 2002). From these studies, it appears that students are entering college with a poor understanding of evolution.

Understanding of the Nature of Science

Students scored a mean of 15.93 on understanding of the NOS, which is an average of 79.65%. At face value, their understanding of the NOS appears to be fairly good, especially when compared to their understanding of evolution. This is comparable to another study with nonmajor biology students that found understanding of the NOS was moderate (3.25 out of 4) but, unlike this dissertation, understanding of the NOS did not significantly correlate with the acceptance of evolution (Rutledge & Sadler, 2011). In contrast, although Carter and Wiles (2014) and Partin, Underwood and Worch (2103) did not report actual understanding scores, they found a positive relationship between the acceptance of evolution and the understanding of the NOS (discussed further below). Similarly, other studies have shown a positive relationship between knowledge about scientific enterprise (the same principle as the NOS) and attitudes towards and knowledge of evolution among university students (Hawley et al., 2011; Short & Hawley, 2012).

Acceptance of Human Evolution

On average, students scored 29.60 on the I-SEA, which is 74% of the possible score. If I applied Rutledge's (1996) categories to this percentage, this mean would fall within the moderate acceptance category. Based on this result, I suggest that students accept human evolution at a relatively lower level than evolution in general (the acceptance of evolution mean fell in the high acceptance category). Although I could not find a study that reported explicit data on the acceptance of human evolution, the dissertation data seem to align with the trend that the acceptance of human evolution is different than the acceptance of evolution in general (Evans, 2008; Nadelson & Hardy, 2015; Sinatra et al., 2003). Indeed, as in the general public (The Gallup Poll, 2014), students seem to accept human evolution to a lesser degree. The students in this dissertation, however, accepted human evolution at a higher rate than the general public acceptance of 19% (The Gallup Poll, 2014).

Factors Related to the Acceptance of Evolution

In this study, the strongest relationship among variables was the correlation between the acceptance of evolution and the acceptance of human evolution ($r = 0.812$). Both of these variables accounted for the majority of the variation in each other (75%). It is logical that there would be a strong relationship between these two variables because presumably one would not accept human evolution without also accepting evolution overall. The understanding of evolution was also highly correlated with the acceptance of evolution ($r = 0.536$) and, when human evolution was removed from the analysis,

understanding of evolution was the best explanation for the variance in the acceptance of evolution (partial correlation coefficient = 0.433).

The same held true for the acceptance of human evolution, albeit to a lesser degree. Once the acceptance of evolution was removed, understanding of evolution accounted for approximately 30% of the explained variation in the scores on the I-SEA. The positive relationship between the understanding and acceptance of evolution is evident in the existing literature as well (Brown, 2015; Moore et al., 2011; Nehm, Kim, & Sheppard, 2009) and supports the idea that an increased knowledge base of evolution can lead to greater acceptance of evolution. If that is the case, better instruction in evolution could result in a more scientifically literate population.

Additionally, understanding of the NOS was moderately positively correlated with the acceptance of both evolution (r = 0.497) and human evolution (r = 0.358). Understanding of the NOS explained approximately 30% and 23% of the explained variance in the acceptance of evolution and human evolution. These results also supported previous research that indicated understanding of the NOS and evolution are positively correlated (Carter & Wiles, 2014; Hawley et al., 2011; Partin, et al., 2103; Short & Hawley, 2012). It is important to note that due to the low Cronbach's alpha on these items (0.444), the questions used to assess understanding of the NOS may not accurately reflect student understanding of the NOS. This limitation is discussed further in the next section.

Interestingly, the understanding of the NOS was more strongly correlated with acceptance of evolution (r = 0.497) than human evolution (r = 0.358). Additionally,

multiple regression analysis indicated that understanding of the NOS and evolution, along with biology/science course experience, career goals and demographic variables, explained 22% of the variance in the I-SEA scores. The low explanatory value of all of the factors measured supports the idea that, like the general public, community college students accept human evolution differently than they accept general evolution.

Limitations and Recommendations for Future Research

There are several limitations to this study that provide suggestions for future research opportunities. The first two limitations are temporal: (a) the surveys were administered during the summer and fall semesters, and (b) they were administered in the first few weeks of each course. Even though a *t*-test indicated no significant difference in the acceptance of evolution between the summer and the fall, it is possible that students enrolled in courses over the summer may be different in some important way (e.g., level of understanding of evolution, demographically) than those enrolled in the fall. Furthermore, some professors may provide explicit instruction on evolution in the first few weeks of class, thereby changing student perceptions of evolution. To obtain a more accurate measure of student understanding and acceptance of evolution, with less potential temporal confounds, future researchers could survey students on the first day of class, prior to instruction, and all within the same semester.

Another limitation is that the current study only considered students at one community college. Because regional patterns are evident in the acceptance of evolution (The Pew Research Center, 2014), future research should consider surveying students at multiple schools, across different geographical regions. Additionally, this dissertation did

not take in to account variables that are not academic in nature but may play a role in the acceptance of evolution. In this study, the variance in the scores of the acceptance of evolution and human evolution was only partially explained by the variables that were measured in this dissertation other than each other (43% and 22%, respectively), which suggests there may be other factors at play. For example, higher socioeconomic status has been linked with the acceptance of evolution (Newport, 2004) and this factor was not measured. Also, several studies have demonstrated negative correlations between religiosity and/or conservative religion and the acceptance of evolution (Brown, 2015; Cotner et al., 2010; The Pew Research Center, 2015; Rice et al., 2011). Although this variable was excluded from this study (due to reluctance of the administration to have students report their religious views), it may be important for consideration in future studies.

The survey instrument employed in this study is in itself a limitation. Specifically, the items for each scale were selected from different existing measures, which means they may not hold their reliability or validity once removed from the existing measure. Whereas Cronbach's alphas revealed a high or acceptable level of internal consistency for the understanding and acceptance of evolution and acceptance of human evolution, the items selected to measure understanding of the NOS appear to be lacking internal consistency. Although this may be in part attributable to the small number of items (four questions), I cannot be confident that these items reliably measured student understanding of the NOS. Thus, researchers should consider using another instrument in its entirety or

possibly administering more than one instrument (one per construct) as others have done (e.g., Carter & Wiles, 2014).

The use of full existing instruments would also allow for a more appropriate comparison between the results in this study and previous research. For example, this dissertation measured understanding of evolution using LSCI items whereas some other recent studies have used the Knowledge of Evolution Exam (e.g., Brown, 2015; Moore et al., 2009). This 10-question, multiple-choice exam was developed for nonmajor biology students (Cotner et al., 2010) and requires only basic knowledge of evolution (Moore et al., 2011).

Additionally, given more time and funding, it may be beneficial to conduct further analyses on the current dataset. I would like to complete an item analysis to explore which items were the most challenging for students in understanding evolution. I would also like to examine the trends among specific items on the MATE and I-SEA to make comparisons among each student regarding their acceptance of evolution and human evolution.

Finally, it is also interesting to observe that experience with college biology and/or science classes, enrollment in majors courses versus courses comprised of majors and nonmajors, and career goals did not contribute significantly to the variance in the acceptance of evolution or human evolution scores. Further analysis might also consider individual statistical analysis between each scale and each demographic variable, separately.

Conclusion

This dissertation explored relationships among academic factors and the acceptance of evolution with a survey of 867 community college students who were enrolled in a variety of life sciences classes. Students completed a survey about their attitudes towards and understanding of evolution, understanding of the NOS, the acceptance of human evolution, experience with college biology and science classes, career goals, and basic demographic details.

The results of this study indicated that the acceptance of evolution and human evolution were higher among this community college student population than among the general public. Students had a poor understanding of evolution and a moderately good understanding of the NOS. The acceptance of evolution and human evolution were positively correlated with each other and positively correlated with the understanding of evolution and the NOS.

These data, which are similar to those in previous studies, have broader implications for science educators. If science educators agree that one of the goals of science education is to increase the understanding of evolution, if not the acceptance of evolution, the fact that students enter college with limited understanding of evolution is problematic. On average, students in this study were only able to correctly answer half of the questions about evolution and these are questions that were derived from science standards at the eighth-grade level. This result may mean that students either are not learning the material in their K-12 education or they are not retaining it.

Given the centrality of evolution to biology, a clear understanding of evolution is foundational for producing a scientifically literate citizen. It is interesting to note that in this study, students did not seem to understand evolution at a high level but they accepted it at a high rate. Perhaps there is some insight to be gained from this finding. Although half of the general public rejects evolution (The Gallup Poll, 2014), it is clear that understanding evolution (and science as a whole) is not the only factor affecting the acceptance of evolution. If it were, more students in this study may have rejected evolution based on their lack of understanding. These other factors might include for example, religiosity, cognitive disposition, and previous exposure to evolution.

Although this study found a positive connection between understanding and acceptance of evolution, it is essential that science educators continue to explore how students learn and accept evolution and to consider factors beyond the academic sphere. Given that increasing acceptance of evolution may not just be a matter of increasing understanding of the greater concept of evolution, further exploration of the obstacles to accepting evolution (e.g., religiosity) might aid the development of useful strategies to improve the teaching of evolution.

Appendix A: Survey Instrument

For the following statements, please indicate your agreement/disagreement with the given statements by filling in the bubble of the corresponding letter on your scantron using the following scale:

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

1. For scientific evidence to be deemed adequate, it must be reproducible by others.
2. Scientific ideas can be tested and supported by feelings and beliefs.
3. Scientific explanations can be supernatural.
4. Good theories give rise to testable predictions.
5. Organisms existing today are the result of evolutionary processes that have occurred over millions of years.
6. The theory of evolution is incapable of being scientifically tested.
7. Modern humans are the product of evolutionary processes that have occurred over millions of years.
8. The theory of evolution is based on speculation and not valid scientific observation and testing.
9. Most scientists accept evolutionary theory to be a scientifically valid theory.
10. The available data are ambiguous (unclear) as to whether evolution actually occurs.
11. The age of the earth is less than 20,000 years.
12. There is a significant body of data that supports evolutionary theory.
13. Organisms exist today in essentially the same form in which they always have.
14. Evolution in not a scientifically valid theory.
15. The age of the earth is at least 4 billion years.
16. Current evolutionary theory is the result of sound scientific research and methodology.
17. Evolutionary theory generates testable predictions with respect to the characteristics of life.
18. The theory of evolution cannot be correct since it disagrees with the religious scriptural account of creation.
19. Humans exist today in essentially the same form in which they always have.
20. Evolutionary theory is supported by factual historical and laboratory data.
21. Much of the scientific community doubts if evolution occurs.
22. The theory of evolution brings meaning to the diverse characteristics and behaviors

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

observed in living forms.

23. With few exceptions, organisms on earth came into existence at about the same time.
24. Evolution is a scientifically valid theory.
25. There is reliable evidence to support the theory that describes how humans were derived from ancestral primates.
26. Although humans may adapt, humans have not/do not evolve.
27. I think that the physical structures of humans are too complex to have evolved.
28. I think that humans and apes share an ancient ancestor.
29. I think that humans evolve.
30. Humans do not evolve; they can only change their behavior.
31. The many characteristics that humans share with other primates (i.e., chimpanzees, gorillas) can best be explained by our sharing a common ancestor.
32. Physical variations in humans (i.e., eye color, skin color) were derived from the same processes that produce variation in other groups of organisms.

Instructions: Read the questions below. For each question, select the single best answer choice.

1. *Which of the following can become extinct?

    a. Plants, animals and microorganisms.
    b. Plants and animals, but not microorganisms.
    c. Only plants.
    d. Only animals.
    e. Only microorganisms.

2. *Present day giraffes have long necks because:

    a. they stretch them to reach the trees for food.
    b. their ancestors adapted to have long necks overtime.
    c. giraffes with the longest necks are the strongest and most perfect.
    d. their neck length increases their body temperature.
    e. their neck length increases their speed.

3. *How would a scientist explain the presence of the hard, outer shell in lobsters?

   Lobsters:

   a. inherit their shell, which evolved over many generations.
   b. learn to grow an outer shell from their parents.
   c. discovered how to grow an outer shell and passed that on to their offspring.
   d. grow an outer shell in response to predators.
   e. prefer an outer shell to an internal skeleton.

4. *The flu virus has most likely spread because:

   a. humans are slowly being exterminated.
   b. it keeps adapting to new environments.
   c. flu virus wants to infect people everywhere.
   d. the virus is smarter, faster and stronger than most people.
   e. overcrowding and pollution keep it alive and contagious.

Instructions: For the items below, please choose the answer choice that you feel is most correct.

1. Please choose which course number you are in today:

   a. BIO 1, 1H, or 1L
   b. BIO 3, 43, 55, or 121
   c. BIO 19, 44, or 71
   d. BIO 10, 11, 12, or 15
   e. BIO 2, 5, 16, 93, 94, 97, or 99

2. Including today's course, how many college science courses have you taken?

   a. 1
   b. 2
   c. 3
   d. 4
   e. More than 4

3. Including today's course, how many college biology courses have you taken?

   a. 1
   b. 2
   c. 3
   d. 4
   e. More than 4

4. Which of the following best describes your educational/ career goals?

   a. I hope to have a career in biology.
   b. I hope to have a career in a life science (biology) related field.
   c. I hope to have a career in a non-life science field but still in science.
   d. I hope to have a career in a field outside of science.
   e. I have not yet decided.

5. Your sex:

   a. Female
   b. Male
   c. Prefer not to say

6. Your ethnicity:

   a. White/European American
   b. Black/African American
   c. Hispanic/Latino American
   d. Asian American
   e. Other

7. Your age (in years):

   a. 18-21
   b. 22-29
   c. 30-39
   d. 40-49
   e. 50 or older

**items are not actual survey items but are representative*

Appendix B: Consent Information

TITLE OF STUDY: Factors that Correlate with Community College Students' Acceptance of Evolution

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ORANGE, CA 92866

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STUDENT INVESTIGATOR Meredith Dorner
College of Educational Studies
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dorne101@mail.chapman.edu

You are being invited to participate in a research study. Participation in this study is completely voluntary. Please read the information below and ask questions about anything that you do not understand.

PURPOSE:
This study is an examination of community college students' attitudes towards evolution, and students' understanding of evolution and the nature of science.

NUMBER OF PARTICIPANTS & STUDY LOCATION:
This study will enroll approximately 1000 community college undergraduate students. All study procedures will be done on community college campuses (Irvine Valley, MiraCosta, Orange Coast, and Saddleback) and will take place during life sciences classes.

QUALIFICATION(S) TO PARTICIPATE:
In order to participate in this study, you must be 18 years of age or older, enrolled in a life sciences course at one of the community colleges listed above, and be able to read English.

TITLE OF STUDY: Factors that Correlate with Community College Students' Acceptance of Evolution

PROCEDURES:

Participation in this study will include the completion of a short 44-item survey in your life science classroom. The survey is completely anonymous and should take approximately 20 minutes or less to complete. All students will receive a survey and all students will return a survey at the end of the survey time period. Only those who wish to participate will actually complete the survey (thereby protecting the anonymity of those who do not wish to participate).

BENEFITS:

You will not directly benefit from participation in this study.

RISKS:

There are no known harms or discomforts associated with this study.

PRIVACY & CONFIDENTIALITY:

The surveys will be stored in a locked file cabinet to which only the investigators will have access. Because the survey is anonymous, the data you provide cannot be linked individually to you.

COMPENSATION, REIMBURSEMENT, COSTS:

You will not be compensated for your participation in this study and there is no cost to participate.

CONTACT INFORMATION:

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Meredith Dorner, Student Investigator
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FOR QUESTIONS RELATED TO STUDY or TO REPORT A CONCERN:

If you have any questions regarding the research or your participation in the study or about the consent form, please contact the student investigator listed above.

Approved by IRB on: 5/19/2015 IRB #: IORG0007566, 00009084 Expiration Date:

6/19/2015

FOR IRB USE ONLY

TITLE OF STUDY: Factors that Correlate with Community College Students' Acceptance of Evolution
If you would like to report a concern about the study or the informed consent process, you may contact Chapman University's Institutional Review Board, Office of Research and Sponsored Programs Administration by phone (714)-628-7392 or (714) 628-2805, by email at irb@chapman.edu, or by mail at Chapman University, ORSPA, One University Dr. Orange, CA 92866.

Participation in this study is completely voluntary. You may refuse to answer any questions or discontinue your involvement at any time without penalty or loss of benefits to which you might otherwise be entitled. Your decision will not affect any potential future relationship or employment with Chapman University.
This research has been explained to me and I have had any questions regarding my participation in the study answered to my satisfaction.

[ ] Yes, I agree and give my consent to participate in the research as described.

[ ] No, I do not wish to participate in the above research.

Approved by IRB on: 5/19/2015 IRB #: IORG0007566, 00009084 Expiration Date:

6/19/2015

FOR IRB USE ONLY

Appendix C: Multiple Regression Data Output for Prediction of MATE Score with All Variables

Descriptive Statistics

	Mean	Std. Deviation	N
MATESCORE	77.32	13.667	867
MosartTOTAL	5.05	2.450	867
NOSSCORE	15.93	2.542	867
ISEASCORE	29.60	7.186	867
biomajor	.1165	.32100	867
BIORELATEDMAJOR	.3022	.45947	867
SCIENCEMAJOR	.1915	.39368	867
NONSCIENCEMAJOR	.2457	.43074	867
UNDECIDEDMAJOR	.1442	.35147	867
OTHERETHNIC	.1292	.33559	867
WHITE	.3033	.45997	867
BLACK	.0208	.14267	867
HISPANIC	.2157	.41153	867
ASIAN	.3310	.47085	867
AGE	.4406	.71900	867
COURSEMAJORMIX	.5917	.49180	867

Correlations

		MATESCORE	Mosart TOTAL	NOSSCORE	ISEASCORE	biomajor
Pearson Correlation	MATESCORE	1.000	.536	.497	.812	.018
	MosartTOTAL	.536	1.000	.378	.408	-.019
	NOSSCORE	.497	.378	1.000	.358	.025
	ISEASCORE	.812	.408	.358	1.000	.031
	biomajor	.018	-.019	.025	.031	1.000
	BIORELATEDMAJOR	.119	.107	.094	.089	-.239
	SCIENCEMAJOR	.033	.012	.046	-.007	-.177
	NONSCIENCEMAJOR	-.102	-.084	-.078	-.086	-.207
	UNDECIDEDMAJOR	-.085	-.033	-.102	-.031	-.149
	OTHERETHNIC	.051	-.021	.063	.005	.021
	WHITE	.044	.102	.062	-.008	.050
	BLACK	-.089	-.075	-.050	-.049	-.002
	HISPANIC	-.026	-.114	-.073	.008	-.033
	ASIAN	-.030	.038	-.027	.012	-.034
	AGE	.016	.008	.053	-.006	-.003
	COURSEMAJORMIX	-.098	-.125	-.116	-.066	-.181

Correlations

		BIORELATEDMAJOR	SCIENCE MAJOR	NON SCIENCE MAJOR	UNDECIDEDMAJOR	OTHER ETHNIC
Pearson Correlation	MATESCORE	.119	.033	-.102	-.085	.051
	MosartTOTAL	.107	.012	-.084	-.033	-.021
	NOSSCORE	.094	.046	-.078	-.102	.063
	ISEASCORE	.089	-.007	-.086	-.031	.005
	biomajor	-.239	-.177	-.207	-.149	.021
	BIORELATEDMAJOR	1.000	-.320	-.376	-.270	.016
	SCIENCEMAJOR	-.320	1.000	-.278	-.200	-.004
	NONSCIENCEMAJOR	-.376	-.278	1.000	-.234	-.060
	UNDECIDEDMAJOR	-.270	-.200	-.234	1.000	.038
	OTHERETHNIC	.016	-.004	-.060	.038	1.000
	WHITE	-.063	.010	.055	-.042	-.254
	BLACK	-.008	-.009	.067	-.060	-.056
	HISPANIC	-.076	.051	.059	.000	-.202
	ASIAN	.119	-.050	-.083	.032	-.271
	AGE	.065	.024	-.018	-.087	.022
	COURSEMAJORMIX	-.337	.082	.327	.114	-.023
Sig. (1-tailed)	MATESCORE	.000	.164	.001	.006	.065
	MosartTOTAL	.001	.360	.006	.163	.264
	NOSSCORE	.003	.088	.011	.001	.032
	ISEASCORE	.005	.415	.006	.182	.442
	biomajor	.000	.000	.000	.000	.269
	BIORELATEDMAJOR	.	.000	.000	.000	.318
	SCIENCEMAJOR	.000	.	.000	.000	.455
	NONSCIENCEMAJOR	.000	.000	.	.000	.039
	UNDECIDEDMAJOR	.000	.000	.000	.	.134
	OTHERETHNIC	.318	.455	.039	.134	.
	WHITE	.032	.379	.054	.107	.000
	BLACK	.410	.394	.024	.039	.049
	HISPANIC	.012	.066	.041	.496	.000
	ASIAN	.000	.073	.007	.171	.000
	AGE	.028	.241	.298	.005	.256
	COURSEMAJORMIX	.000	.008	.000	.000	.251
N	MATESCORE	867	867	867	867	867
	MosartTOTAL	867	867	867	867	867
	NOSSCORE	867	867	867	867	867
	ISEASCORE	867	867	867	867	867

	biomajor	867	867	867	867	867
	BIORELATEDMAJOR	867	867	867	867	867
	SCIENCEMAJOR	867	867	867	867	867
	NONSCIENCEMAJOR	867	867	867	867	867
	UNDECIDEDMAJOR	867	867	867	867	867
	OTHERETHNIC	867	867	867	867	867
	WHITE	867	867	867	867	867
	BLACK	867	867	867	867	867
	HISPANIC	867	867	867	867	867
	ASIAN	867	867	867	867	867
	AGE	867	867	867	867	867
	COURSEMAJORMIX	867	867	867	867	867

Sig. (1-tailed)	MATESCORE	.	.000	.000	.000	.294
	MosartTOTAL	.000	.	.000	.000	.291
	NOSSCORE	.000	.000	.	.000	.231
	ISEASCORE	.000	.000	.000	.	.181
	biomajor	.294	.291	.231	.181	.
	BIORELATEDMAJOR	.000	.001	.003	.005	.000
	SCIENCEMAJOR	.164	.360	.088	.415	.000
	NONSCIENCEMAJOR	.001	.006	.011	.006	.000
	UNDECIDEDMAJOR	.006	.163	.001	.182	.000
	OTHERETHNIC	.065	.264	.032	.442	.269
	WHITE	.097	.001	.033	.405	.072
	BLACK	.004	.013	.069	.074	.471
	HISPANIC	.224	.000	.016	.402	.165
	ASIAN	.187	.129	.212	.362	.160
	AGE	.321	.402	.059	.434	.471
	COURSEMAJORMIX	.002	.000	.000	.026	.000
N	MATESCORE	867	867	867	867	867
	MosartTOTAL	867	867	867	867	867
	NOSSCORE	867	867	867	867	867
	ISEASCORE	867	867	867	867	867
	biomajor	867	867	867	867	867
	BIORELATEDMAJOR	867	867	867	867	867
	SCIENCEMAJOR	867	867	867	867	867
	NONSCIENCEMAJOR	867	867	867	867	867
	UNDECIDEDMAJOR	867	867	867	867	867
	OTHERETHNIC	867	867	867	867	867
	WHITE	867	867	867	867	867
	BLACK	867	867	867	867	867
	HISPANIC	867	867	867	867	867
	ASIAN	867	867	867	867	867
	AGE	867	867	867	867	867
	COURSEMAJORMIX	867	867	867	867	867

Correlations

		WHITE	BLACK	HISPANIC	ASIAN	AGE	COURSE MAJOR MIX
Pearson Correlation	MATESCORE	.044	-.089	-.026	-.030	.016	-.098
	MosartTOTAL	.102	-.075	-.114	.038	.008	-.125
	NOSSCORE	.062	-.050	-.073	-.027	.053	-.116
	ISEASCORE	-.008	-.049	.008	.012	-.006	-.066

	biomajor	.050	-.002	-.033	-.034	-.003	-.181
	BIORELATEDMAJOR	-.063	-.008	-.076	.119	.065	-.337
	SCIENCEMAJOR	.010	-.009	.051	-.050	.024	.082
	NONSCIENCEMAJOR	.055	.067	.059	-.083	-.018	.327
	UNDECIDEDMAJOR	-.042	-.060	.000	.032	-.087	.114
	OTHERETHNIC	-.254	-.056	-.202	-.271	.022	-.023
	WHITE	1.000	-.096	-.346	-.464	.063	.017
	BLACK	-.096	1.000	-.076	-.102	.192	.006
	HISPANIC	-.346	-.076	1.000	-.369	-.072	.145
	ASIAN	-.464	-.102	-.369	1.000	-.073	-.129
	AGE	.063	.192	-.072	-.073	1.000	-.088
	COURSEMAJORMIX	.017	.006	.145	-.129	-.088	1.000
Sig. (1-tailed)	MATESCORE	.097	.004	.224	.187	.321	.002
	MosartTOTAL	.001	.013	.000	.129	.402	.000
	NOSSCORE	.033	.069	.016	.212	.059	.000
	ISEASCORE	.405	.074	.402	.362	.434	.026
	biomajor	.072	.471	.165	.160	.471	.000
	BIORELATEDMAJOR	.032	.410	.012	.000	.028	.000
	SCIENCEMAJOR	.379	.394	.066	.073	.241	.008
	NONSCIENCEMAJOR	.054	.024	.041	.007	.298	.000
	UNDECIDEDMAJOR	.107	.039	.496	.171	.005	.000
	OTHERETHNIC	.000	.049	.000	.000	.256	.251
	WHITE	.	.002	.000	.000	.031	.306
	BLACK	.002	.	.012	.001	.000	.433
	HISPANIC	.000	.012	.	.000	.017	.000
	ASIAN	.000	.001	.000	.	.016	.000
	AGE	.031	.000	.017	.016	.	.005
	COURSEMAJORMIX	.306	.433	.000	.000	.005	.
N	MATESCORE	867	867	867	867	867	867
	MosartTOTAL	867	867	867	867	867	867
	NOSSCORE	867	867	867	867	867	867
	ISEASCORE	867	867	867	867	867	867
	biomajor	867	867	867	867	867	867

	BIORELATEDMAJOR	867	867	867	867	867	867
	SCIENCEMAJOR	867	867	867	867	867	867
	NONSCIENCEMAJOR	867	867	867	867	867	867
	UNDECIDEDMAJOR	867	867	867	867	867	867
	OTHERETHNIC	867	867	867	867	867	867
	WHITE	867	867	867	867	867	867
	BLACK	867	867	867	867	867	867
	HISPANIC	867	867	867	867	867	867
	ASIAN	867	867	867	867	867	867
	AGE	867	867	867	867	867	867
	COURSEMAJORMIX	867	867	867	867	867	867

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.862[a]	.743	.739	6.976

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	120241.537	13	9249.349	190.074	.000[a]
	Residual	41508.602	853	48.662		
	Total	161750.138	866			

Coefficients[a]

Model		Unstandardized Coefficients	
		B	Std. Error
1	(Constant)	19.302	1.732
	MosartTOTAL	1.075	.112
	NOSSCORE	.927	.105
	ISEASCORE	1.268	.037
	biomajor	-.747	.823
	SCIENCEMAJOR	.188	.718
	NONSCIENCEMAJOR	-.856	.713

UNDECIDEDMAJOR	-1.929	.794
OTHERETHNIC	2.294	.783
WHITE	1.200	.606
BLACK	-2.541	1.744
HISPANIC	.926	.670
AGE	.132	.341
COURSEMAJORMIX	-.039	.549

Coefficients[a]

Model		Standardized Coefficients	t	Sig.	95.0% Confidence Interval for B	
		Beta			Lower Bound	Upper Bound
1	(Constant)		11.144	.000	15.902	22.702
	MosartTOTAL	.193	9.603	.000	.855	1.295
	NOSSCORE	.172	8.814	.000	.721	1.133
	ISEASCORE	.666	33.837	.000	1.194	1.341
	biomajor	-.018	-.908	.364	-2.362	.868
	SCIENCEMAJOR	.005	.262	.793	-1.222	1.598
	NONSCIENCEMAJOR	-.027	-1.201	.230	-2.255	.543
	UNDECIDEDMAJOR	-.050	-2.430	.015	-3.487	-.371
	OTHERETHNIC	.056	2.930	.003	.757	3.830
	WHITE	.040	1.980	.048	.010	2.389
	BLACK	-.027	-1.457	.145	-5.963	.882
	HISPANIC	.028	1.383	.167	-.389	2.241
	AGE	.007	.388	.698	-.536	.801
	COURSEMAJORMIX	-.001	-.071	.943	-1.117	1.039

Coefficients[a]

Model		Correlations			Collinearity Statistics	
		Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)					
	MosartTOTAL	.536	.312	.167	.747	1.339
	NOSSCORE	.497	.289	.153	.786	1.272
	ISEASCORE	.812	.757	.587	.775	1.290
	biomajor	.018	-.031	-.016	.806	1.241
	SCIENCEMAJOR	.033	.009	.005	.703	1.423

NONSCIENCEMAJOR	-.102	-.041	-.021	.596	1.677
UNDECIDEDMAJOR	-.085	-.083	-.042	.722	1.385
OTHERETHNIC	.051	.100	.051	.814	1.228
WHITE	.044	.068	.034	.723	1.383
BLACK	-.089	-.050	-.025	.908	1.101
HISPANIC	-.026	.047	.024	.739	1.353
AGE	.016	.013	.007	.937	1.067
COURSEMAJORMIX	-.098	-.002	-.001	.770	1.298

a. Dependent Variable: MATESCORE

Excluded Variables[b]

Model		Beta In	t	Sig.	Partial Correlation
1	BIORELATEDMAJOR	.[a]	.	.	.
	ASIAN	.[a]	.	.	.

Excluded Variables[b]

Model		Collinearity Statistics		
		Tolerance	VIF	Minimum Tolerance
1	BIORELATEDMAJOR	.000	.	.000
	ASIAN	.000	.	.000

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index
1	1	6.190	1.000
	2	1.142	2.328
	3	1.127	2.344
	4	1.025	2.458
	5	1.011	2.475
	6	.952	2.550
	7	.901	2.621
	8	.631	3.132
	9	.380	4.038
	10	.292	4.606
	11	.210	5.436
	12	.099	7.896
	13	.030	14.319
	14	.011	23.763

Collinearity Diagnostics[a]

		Variance Proportions				
Model	Dimension	(Constant)	MosartTOTAL	NOSSCORE	ISEASCORE	biomajor
1	1	.00	.00	.00	.00	.00
	2	.00	.00	.00	.00	.01
	3	.00	.00	.00	.00	.19
	4	.00	.00	.00	.00	.05
	5	.00	.00	.00	.00	.00
	6	.00	.00	.00	.00	.29
	7	.00	.00	.00	.00	.01
	8	.00	.00	.00	.00	.03
	9	.00	.09	.00	.01	.19
	10	.00	.01	.00	.00	.04
	11	.00	.01	.00	.00	.12
	12	.03	.82	.02	.04	.05
	13	.09	.02	.12	.94	.00
	14	.88	.04	.85	.00	.01

Collinearity Diagnostics[a]

Model	Dimension	Variance Proportions SCIENCEMAJOR	NONSCIENCEMAJOR	UNDECIDED MAJOR	OTHERETHNIC	WHITE
1	1	.00	.00	.00	.00	.00
	2	.00	.02	.13	.03	.01
	3	.00	.09	.00	.09	.01
	4	.03	.01	.01	.18	.14
	5	.33	.06	.11	.03	.00
	6	.03	.00	.03	.00	.10
	7	.00	.10	.21	.25	.00
	8	.04	.00	.00	.00	.00
	9	.09	.02	.06	.01	.02
	10	.02	.02	.01	.36	.68
	11	.41	.62	.37	.00	.00
	12	.03	.03	.03	.03	.01
	13	.01	.01	.01	.01	.01
	14	.00	.01	.03	.00	.00

Collinearity Diagnostics[a]

Model	Dimension	Variance Proportions BLACK	HISPANIC	AGE	COURSEMAJORMIX
1	1	.00	.00	.01	.01
	2	.32	.03	.07	.00
	3	.01	.10	.01	.02
	4	.21	.00	.02	.00
	5	.02	.02	.00	.00
	6	.00	.19	.01	.00
	7	.13	.02	.01	.00
	8	.20	.03	.77	.02
	9	.00	.00	.08	.27
	10	.09	.54	.02	.06
	11	.00	.00	.00	.59
	12	.01	.05	.01	.03
	13	.00	.00	.00	.00
	14	.00	.00	.00	.01

a. Dependent Variable: MATESCORE

Casewise Diagnostics[a]

Case Number	Std. Residual	MATESCORE	Predicted Value	Residual
26	-3.159	43	65.04	-22.038
51	-3.157	63	85.02	-22.024
77	3.324	81	57.81	23.187
99	-3.556	51	75.80	-24.803
164	3.075	78	56.55	21.453
217	3.374	84	60.46	23.536
582	4.168	79	49.93	29.074
585	3.036	77	55.82	21.176

a. Dependent Variable: MATESCORE

Appendix D: Multiple Regression Data Output for Prediction of MATE Score with All Variables Except I-SEA

Descriptive Statistics

	Mean	Std. Deviation	N
MATESCORE	77.32	13.667	867
MosartTOTAL	5.05	2.450	867
NOSSCORE	15.93	2.542	867
biomajor	.1165	.32100	867
BIORELATEDMAJOR	.3022	.45947	867
SCIENCEMAJOR	.1915	.39368	867
NONSCIENCEMAJOR	.2457	.43074	867
UNDECIDEDMAJOR	.1442	.35147	867
OTHERETHNIC	.1292	.33559	867
WHITE	.3033	.45997	867
BLACK	.0208	.14267	867
HISPANIC	.2157	.41153	867
ASIAN	.3310	.47085	867
AGE	.4406	.71900	867
COURSEMAJORMIX	.5917	.49180	867

Correlations

		MATE ORE	Mosart TOTAL	NOSSCORE	biomajor	BIO RELATED MAJOR
Pearson Correlation	MATESCORE	1.000	.536	.497	.018	.119
	MosartTOTAL	.536	1.000	.378	-.019	.107
	NOSSCORE	.497	.378	1.000	.025	.094
	biomajor	.018	-.019	.025	1.000	-.239
	BIORELATEDMAJOR	.119	.107	.094	-.239	1.000
	SCIENCEMAJOR	.033	.012	.046	-.177	-.320
	NONSCIENCEMAJOR	-.102	-.084	-.078	-.207	-.376
	UNDECIDEDMAJOR	-.085	-.033	-.102	-.149	-.270
	OTHERETHNIC	.051	-.021	.063	.021	.016
	WHITE	.044	.102	.062	.050	-.063
	BLACK	-.089	-.075	-.050	-.002	-.008
	HISPANIC	-.026	-.114	-.073	-.033	-.076
	ASIAN	-.030	.038	-.027	-.034	.119
	AGE	.016	.008	.053	-.003	.065
	COURSEMAJORMIX	-.098	-.125	-.116	-.181	-.337
Sig. (1-tailed)	MATESCORE	.	.000	.000	.294	.000

	MosartTOTAL	.000	.	.000	.291	.001
	NOSSCORE	.000	.000	.	.231	.003
	biomajor	.294	.291	.231	.	.000
	BIORELATEDMAJOR	.000	.001	.003	.000	.
	SCIENCEMAJOR	.164	.360	.088	.000	.000
	NONSCIENCEMAJOR	.001	.006	.011	.000	.000
	UNDECIDEDMAJOR	.006	.163	.001	.000	.000
	OTHERETHNIC	.065	.264	.032	.269	.318
	WHITE	.097	.001	.033	.072	.032
	BLACK	.004	.013	.069	.471	.410
	HISPANIC	.224	.000	.016	.165	.012
	ASIAN	.187	.129	.212	.160	.000
	AGE	.321	.402	.059	.471	.028
	COURSEMAJORMIX	.002	.000	.000	.000	.000
N	MATESCORE	867	867	867	867	867
	MosartTOTAL	867	867	867	867	867
	NOSSCORE	867	867	867	867	867
	biomajor	867	867	867	867	867
	BIORELATEDMAJOR	867	867	867	867	867
	SCIENCEMAJOR	867	867	867	867	867
	NONSCIENCEMAJOR	867	867	867	867	867
	UNDECIDEDMAJOR	867	867	867	867	867
	OTHERETHNIC	867	867	867	867	867
	WHITE	867	867	867	867	867
	BLACK	867	867	867	867	867
	HISPANIC	867	867	867	867	867
	ASIAN	867	867	867	867	867
	AGE	867	867	867	867	867
	COURSEMAJORMIX	867	867	867	867	867

Correlations

		SCIENCE MAJOR	NONSCIENCE MAJOR	UNDECIDED MAJOR	OTHER ETHNIC	WHITE
Pearson Correlation	MATESCORE	.033	-.102	-.085	.051	.044
	MosartTOTAL	.012	-.084	-.033	-.021	.102
	NOSSCORE	.046	-.078	-.102	.063	.062
	biomajor	-.177	-.207	-.149	.021	.050
	BIORELATEDMAJOR	-.320	-.376	-.270	.016	-.063
	SCIENCEMAJOR	1.000	-.278	-.200	-.004	.010
	NONSCIENCE MAJOR	-.278	1.000	-.234	-.060	.055
	UNDECIDEDMAJOR	-.200	-.234	1.000	.038	-.042
	OTHERETHNIC	-.004	-.060	.038	1.000	-.254
	WHITE	.010	.055	-.042	-.254	1.000
	BLACK	-.009	.067	-.060	-.056	-.096
	HISPANIC	.051	.059	.000	-.202	-.346
	ASIAN	-.050	-.083	.032	-.271	-.464
	AGE	.024	-.018	-.087	.022	.063
	COURSEMAJORMIX	.082	.327	.114	-.023	.017
Sig. (1-tailed)	MATESCORE	.164	.001	.006	.065	.097
	MosartTOTAL	.360	.006	.163	.264	.001
	NOSSCORE	.088	.011	.001	.032	.033
	biomajor	.000	.000	.000	.269	.072
	BIORELATEDMAJOR	.000	.000	.000	.318	.032
	SCIENCEMAJOR	.	.000	.000	.455	.379
	NONSCIENCEMAJOR	.000	.	.000	.039	.054
	UNDECIDEDMAJOR	.000	.000	.	.134	.107
	OTHERETHNIC	.455	.039	.134	.	.000
	WHITE	.379	.054	.107	.000	.
	BLACK	.394	.024	.039	.049	.002
	HISPANIC	.066	.041	.496	.000	.000
	ASIAN	.073	.007	.171	.000	.000
	AGE	.241	.298	.005	.256	.031
	COURSEMAJORMIX	.008	.000	.000	.251	.306
N	MATESCORE	867	867	867	867	867
	MosartTOTAL	867	867	867	867	867
	NOSSCORE	867	867	867	867	867
	biomajor	867	867	867	867	867
	BIORELATEDMAJOR	867	867	867	867	867
	SCIENCEMAJOR	867	867	867	867	867
	NONSCIENCE MAJOR	867	867	867	867	867
	UNDECIDEDMAJOR	867	867	867	867	867
	OTHERETHNIC	867	867	867	867	867
	WHITE	867	867	867	867	867
	BLACK	867	867	867	867	867

	HISPANIC	867	867	867	867	867
	ASIAN	867	867	867	867	867
	AGE	867	867	867	867	867
	COURSEMAJORMIX	867	867	867	867	867

Correlations

		BLACK	HISPANIC	ASIAN	AGE	COURSE MAJOR MIX
Pearson Correlation	MATESCORE	-.089	-.026	-.030	.016	-.098
	MosartTOTAL	-.075	-.114	.038	.008	-.125
	NOSSCORE	-.050	-.073	-.027	.053	-.116
	biomajor	-.002	-.033	-.034	-.003	-.181
	BIORELATEDMAJOR	-.008	-.076	.119	.065	-.337
	SCIENCEMAJOR	-.009	.051	-.050	.024	.082
	NONSCIENCEMAJOR	.067	.059	-.083	-.018	.327
	UNDECIDEDMAJOR	-.060	.000	.032	-.087	.114
	OTHERETHNIC	-.056	-.202	-.271	.022	-.023
	WHITE	-.096	-.346	-.464	.063	.017
	BLACK	1.000	-.076	-.102	.192	.006
	HISPANIC	-.076	1.000	-.369	-.072	.145
	ASIAN	-.102	-.369	1.000	-.073	-.129
	AGE	.192	-.072	-.073	1.000	-.088
	COURSEMAJORMIX	.006	.145	-.129	-.088	1.000
Sig. (1-tailed)	MATESCORE	.004	.224	.187	.321	.002
	MosartTOTAL	.013	.000	.129	.402	.000
	NOSSCORE	.069	.016	.212	.059	.000
	biomajor	.471	.165	.160	.471	.000
	BIORELATEDMAJOR	.410	.012	.000	.028	.000
	SCIENCEMAJOR	.394	.066	.073	.241	.008
	NONSCIENCEMAJOR	.024	.041	.007	.298	.000
	UNDECIDEDMAJOR	.039	.496	.171	.005	.000
	OTHERETHNIC	.049	.000	.000	.256	.251
	WHITE	.002	.000	.000	.031	.306
	BLACK	.	.012	.001	.000	.433
	HISPANIC	.012	.	.000	.017	.000
	ASIAN	.001	.000	.	.016	.000
	AGE	.000	.017	.016	.	.005
	COURSEMAJORMIX	.433	.000	.000	.005	.
N	MATESCORE	867	867	867	867	867
	MosartTOTAL	867	867	867	867	867
	NOSSCORE	867	867	867	867	867
	biomajor	867	867	867	867	867

BIORELATEDMAJOR	867	867	867	867	867
SCIENCEMAJOR	867	867	867	867	867
NONSCIENCEMAJOR	867	867	867	867	867
UNDECIDEDMAJOR	867	867	867	867	867
OTHERETHNIC	867	867	867	867	867
WHITE	867	867	867	867	867
BLACK	867	867	867	867	867
HISPANIC	867	867	867	867	867
ASIAN	867	867	867	867	867
AGE	867	867	867	867	867
COURSEMAJORMIX	867	867	867	867	867

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.632[a]	.399	.390	10.670

Coefficients[a]

Model		Unstandardized Coefficients	
		B	Std. Error
1	(Constant)	37.482	2.519
	MosartTOTAL	2.281	.162
	NOSSCORE	1.784	.156
	biomajor	-.343	1.258
	SCIENCEMAJOR	-.876	1.098
	NONSCIENCEMAJOR	-2.205	1.088
	UNDECIDEDMAJOR	-2.537	1.214
	OTHERETHNIC	2.136	1.197
	WHITE	.437	.926
	BLACK	-3.051	2.667
	HISPANIC	2.032	1.023
	AGE	-.037	.521
	COURSEMAJORMIX	.408	.840

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	64526.982	12	5377.248	47.233	.000[a]
	Residual	97223.157	854	113.844		
	Total	161750.138	866			

Coefficients[a]

Model		Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	Upper Bound
1	(Constant)		14.882	.000	32.539	42.426
	MosartTOTAL	.409	14.053	.000	1.962	2.600
	NOSSCORE	.332	11.428	.000	1.478	2.091
	biomajor	-.008	-.272	.785	-2.812	2.127
	SCIENCEMAJOR	-.025	-.798	.425	-3.031	1.278
	NONSCIENCEMAJOR	-.070	-2.026	.043	-4.342	-.069
	UNDECIDEDMAJOR	-.065	-2.090	.037	-4.920	-.154
	OTHERETHNIC	.052	1.784	.075	-.214	4.486
	WHITE	.015	.472	.637	-1.381	2.255
	BLACK	-.032	-1.144	.253	-8.285	2.184
	HISPANIC	.061	1.986	.047	.023	4.041
	AGE	-.002	-.072	.943	-1.060	.985
	COURSEMAJORMIX	.015	.486	.627	-1.240	2.056

Coefficients[a]

Model		Correlations Zero-order	Partial	Part	Collinearity Statistics Tolerance	VIF
1	(Constant)					
	MosartTOTAL	.536	.433	.373	.831	1.203
	NOSSCORE	.497	.364	.303	.834	1.199
	biomajor	.018	-.009	-.007	.806	1.241
	SCIENCEMAJOR	.033	-.027	-.021	.704	1.421
	NONSCIENCEMAJOR	-.102	-.069	-.054	.598	1.672
	UNDECIDEDMAJOR	-.085	-.071	-.055	.722	1.385
	OTHERETHNIC	.051	.061	.047	.814	1.228
	WHITE	.044	.016	.013	.724	1.381
	BLACK	-.089	-.039	-.030	.908	1.101
	HISPANIC	-.026	.068	.053	.741	1.349
	AGE	.016	-.002	-.002	.937	1.067
	COURSEMAJORMIX	-.098	.017	.013	.771	1.297

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index
1	1	5.268	1.000
	2	1.141	2.149
	3	1.124	2.164
	4	1.025	2.268
	5	1.011	2.283
	6	.951	2.354
	7	.901	2.418
	8	.630	2.891
	9	.351	3.872
	10	.288	4.278
	11	.209	5.022
	12	.090	7.653
	13	.011	21.889

Collinearity Diagnostics[a]

		Variance Proportions				
Model	Dimension	(Constant)	MosartTOTAL	NOSSCORE	biomajor	SCIENCEMAJOR
1	1	.00	.00	.00	.00	.00
	2	.00	.00	.00	.03	.00
	3	.00	.00	.00	.18	.00
	4	.00	.00	.00	.05	.03
	5	.00	.00	.00	.00	.33
	6	.00	.00	.00	.29	.03
	7	.00	.00	.00	.01	.00
	8	.00	.00	.00	.03	.04
	9	.00	.13	.00	.18	.09
	10	.00	.04	.00	.03	.02
	11	.00	.01	.00	.12	.41
	12	.06	.76	.05	.06	.04
	13	.93	.04	.94	.01	.00

Collinearity Diagnostics[a]

Model	Dimension	Variance Proportions				
		NONSCIENCEMAJOR	UNDECIDEDMAJOR	OTHERETHNIC	WHITE	BLACK
1	1	.00	.00	.00	.01	.00
	2	.01	.13	.02	.02	.31
	3	.10	.01	.11	.01	.02
	4	.01	.01	.18	.14	.21
	5	.06	.11	.03	.00	.03
	6	.00	.03	.00	.09	.00
	7	.10	.21	.25	.00	.12
	8	.00	.00	.00	.00	.20
	9	.02	.05	.00	.00	.01
	10	.02	.00	.36	.70	.08
	11	.62	.37	.00	.00	.00
	12	.05	.04	.04	.02	.01
	13	.01	.02	.00	.00	.00

Collinearity Diagnostics[a]

Model	Dimension	Variance Proportions		
		HISPANIC	AGE	COURSEMAJORMIX
1	1	.00	.01	.01
	2	.04	.07	.00
	3	.09	.01	.01
	4	.00	.02	.00
	5	.02	.00	.00
	6	.20	.01	.00
	7	.02	.01	.00
	8	.03	.76	.02
	9	.01	.10	.31
	10	.52	.01	.02
	11	.00	.00	.58
	12	.06	.02	.03
	13	.00	.00	.01

Casewise Diagnostics[a]

Case Number	Std. Residual	MATESCORE	Predicted Value	Residual
4	-3.123	41	74.33	-33.326
8	-3.060	44	76.64	-32.645
10	-3.287	41	76.07	-35.074
16	-3.994	43	85.62	-42.619
22	-3.196	51	85.10	-34.096
87	-3.013	39	71.15	-32.146
593	-3.517	54	91.53	-37.529

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	55.64	97.97	77.32	8.632	867
Std. Predicted Value	-2.511	2.393	.000	1.000	867
Standard Error of Predicted Value	.875	2.882	1.273	.293	867
Adjusted Predicted Value	55.42	97.95	77.32	8.637	867
Residual	-42.619	28.675	.000	10.596	867
Std. Residual	-3.994	2.688	.000	.993	867
Stud. Residual	-4.022	2.724	.000	1.001	867
Deleted Residual	-43.217	29.464	.002	10.759	867
Stud. Deleted Residual	-4.059	2.735	.000	1.002	867
Mahal. Distance	4.820	62.175	11.986	7.693	867
Cook's Distance	.000	.023	.001	.002	867
Centered Leverage Value	.006	.072	.014	.009	867

a. Dependent Variable: MATESCORE

Appendix E: Multiple Regression Data for Prediction of I-SEA Score with All Variables

Descriptive Statistics

	Mean	Std. Deviation	N
ISEASCORE	29.60	7.186	867
MosartTOTAL	5.05	2.450	867
NOSSCORE	15.93	2.542	867
biomajor	.1165	.32100	867
BIORELATEDMAJOR	.3022	.45947	867
SCIENCEMAJOR	.1915	.39368	867
NONSCIENCEMAJOR	.2457	.43074	867
UNDECIDEDMAJOR	.1442	.35147	867
OTHERETHNIC	.1292	.33559	867
WHITE	.3033	.45997	867
BLACK	.0208	.14267	867
HISPANIC	.2157	.41153	867
ASIAN	.3310	.47085	867
AGE	.4406	.71900	867
COURSEMAJORMIX	.5917	.49180	867
MATESCORE	77.32	13.667	867

Correlations

		ISEASCORE	Mosart TOTAL	NOSSCORE	biomajor	BIORELATED MAJOR
Pearson Correlation	ISEASCORE	1.000	.408	.358	.031	.089
	MosartTOTAL	.408	1.000	.378	-.019	.107
	NOSSCORE	.358	.378	1.000	.025	.094
	biomajor	.031	-.019	.025	1.000	-.239
	BIORELATEDMAJOR	.089	.107	.094	-.239	1.000
	SCIENCEMAJOR	-.007	.012	.046	-.177	-.320
	NONSCIENCEMAJOR	-.086	-.084	-.078	-.207	-.376
	UNDECIDEDMAJOR	-.031	-.033	-.102	-.149	-.270
	OTHERETHNIC	.005	-.021	.063	.021	.016
	WHITE	-.008	.102	.062	.050	-.063
	BLACK	-.049	-.075	-.050	-.002	-.008
	HISPANIC	.008	-.114	-.073	-.033	-.076
	ASIAN	.012	.038	-.027	-.034	.119
	AGE	-.006	.008	.053	-.003	.065
	COURSEMAJORMIX	-.066	-.125	-.116	-.181	-.337

	MATESCORE	.812	.536	.497	.018	.119
Sig. (1-tailed)	ISEASCORE	.	.000	.000	.181	.005
	MosartTOTAL	.000	.	.000	.291	.001
	NOSSCORE	.000	.000	.	.231	.003
	biomajor	.181	.291	.231	.	.000
	BIORELATEDMAJOR	.005	.001	.003	.000	.
	SCIENCEMAJOR	.415	.360	.088	.000	.000
	NONSCIENCEMAJOR	.006	.006	.011	.000	.000
	UNDECIDEDMAJOR	.182	.163	.001	.000	.000
	OTHERETHNIC	.442	.264	.032	.269	.318
	WHITE	.405	.001	.033	.072	.032
	BLACK	.074	.013	.069	.471	.410
	HISPANIC	.402	.000	.016	.165	.012
	ASIAN	.362	.129	.212	.160	.000
	AGE	.434	.402	.059	.471	.028
	COURSEMAJORMIX	.026	.000	.000	.000	.000
	MATESCORE	.000	.000	.000	.294	.000
N	ISEASCORE	867	867	867	867	867
	MosartTOTAL	867	867	867	867	867
	NOSSCORE	867	867	867	867	867
	biomajor	867	867	867	867	867
	BIORELATEDMAJOR	867	867	867	867	867
	SCIENCEMAJOR	867	867	867	867	867
	NONSCIENCEMAJOR	867	867	867	867	867
	UNDECIDEDMAJOR	867	867	867	867	867
	OTHERETHNIC	867	867	867	867	867
	WHITE	867	867	867	867	867
	BLACK	867	867	867	867	867
	HISPANIC	867	867	867	867	867
	ASIAN	867	867	867	867	867
	AGE	867	867	867	867	867
	COURSEMAJORMIX	867	867	867	867	867
	MATESCORE	867	867	867	867	867

Correlations

		SCIENCE MAJOR	NONSCIENCE MAJOR	UNDECIDED MAJOR	OTHER ETHNIC	WHITE
Pearson Correlation	ISEASCORE	-.007	-.086	-.031	.005	-.008
	MosartTOTAL	.012	-.084	-.033	-.021	.102
	NOSSCORE	.046	-.078	-.102	.063	.062
	biomajor	-.177	-.207	-.149	.021	.050
	BIORELATEDMAJOR	-.320	-.376	-.270	.016	-.063

	SCIENCEMAJOR	1.000	-.278	-.200	-.004	.010
	NONSCIENCEMAJOR	-.278	1.000	-.234	-.060	.055
	UNDECIDEDMAJOR	-.200	-.234	1.000	.038	-.042
	OTHERETHNIC	-.004	-.060	.038	1.000	-.254
	WHITE	.010	.055	-.042	-.254	1.000
	BLACK	-.009	.067	-.060	-.056	-.096
	HISPANIC	.051	.059	.000	-.202	-.346
	ASIAN	-.050	-.083	.032	-.271	-.464
	AGE	.024	-.018	-.087	.022	.063
	COURSEMAJORMIX	.082	.327	.114	-.023	.017
	MATESCORE	.033	-.102	-.085	.051	.044
Sig. (1-tailed)	ISEASCORE	.415	.006	.182	.442	.405
	MosartTOTAL	.360	.006	.163	.264	.001
	NOSSCORE	.088	.011	.001	.032	.033
	biomajor	.000	.000	.000	.269	.072
	BIORELATEDMAJOR	.000	.000	.000	.318	.032
	SCIENCEMAJOR	.	.000	.000	.455	.379
	NONSCIENCEMAJOR	.000	.	.000	.039	.054
	UNDECIDEDMAJOR	.000	.000	.	.134	.107
	OTHERETHNIC	.455	.039	.134	.	.000
	WHITE	.379	.054	.107	.000	.
	BLACK	.394	.024	.039	.049	.002
	HISPANIC	.066	.041	.496	.000	.000
	ASIAN	.073	.007	.171	.000	.000
	AGE	.241	.298	.005	.256	.031
	COURSEMAJORMIX	.008	.000	.000	.251	.306
	MATESCORE	.164	.001	.006	.065	.097
N	ISEASCORE	867	867	867	867	867
	MosartTOTAL	867	867	867	867	867
	NOSSCORE	867	867	867	867	867
	biomajor	867	867	867	867	867
	BIORELATEDMAJOR	867	867	867	867	867
	SCIENCEMAJOR	867	867	867	867	867
	NONSCIENCEMAJOR	867	867	867	867	867
	UNDECIDEDMAJOR	867	867	867	867	867
	OTHERETHNIC	867	867	867	867	867
	WHITE	867	867	867	867	867
	BLACK	867	867	867	867	867
	HISPANIC	867	867	867	867	867

	ASIAN	867	867	867	867	867
	AGE	867	867	867	867	867
	COURSEMAJORMIX	867	867	867	867	867
	MATESCORE	867	867	867	867	867

Correlations

		BLACK	HISPANIC	ASIAN	AGE	COURSE MAJOR MIX	MATE SCORE
Pearson Correlation	ISEASCORE	-.049	.008	.012	-.006	-.066	.812
	MosartTOTAL	-.075	-.114	.038	.008	-.125	.536
	NOSSCORE	-.050	-.073	-.027	.053	-.116	.497
	biomajor	-.002	-.033	-.034	-.003	-.181	.018
	BIORELATEDMAJOR	-.008	-.076	.119	.065	-.337	.119
	SCIENCEMAJOR	-.009	.051	-.050	.024	.082	.033
	NONSCIENCEMAJOR	.067	.059	-.083	-.018	.327	-.102
	UNDECIDEDMAJOR	-.060	.000	.032	-.087	.114	-.085
	OTHERETHNIC	-.056	-.202	-.271	.022	-.023	.051
	WHITE	-.096	-.346	-.464	.063	.017	.044
	BLACK	1.000	-.076	-.102	.192	.006	-.089
	HISPANIC	-.076	1.000	-.369	-.072	.145	-.026
	ASIAN	-.102	-.369	1.000	-.073	-.129	-.030
	AGE	.192	-.072	-.073	1.000	-.088	.016
	COURSEMAJORMIX	.006	.145	-.129	-.088	1.000	-.098
	MATESCORE	-.089	-.026	-.030	.016	-.098	1.000
Sig. (1-tailed)	ISEASCORE	.074	.402	.362	.434	.026	.000
	MosartTOTAL	.013	.000	.129	.402	.000	.000
	NOSSCORE	.069	.016	.212	.059	.000	.000
	biomajor	.471	.165	.160	.471	.000	.294
	BIORELATEDMAJOR	.410	.012	.000	.028	.000	.000
	SCIENCEMAJOR	.394	.066	.073	.241	.008	.164
	NONSCIENCEMAJOR	.024	.041	.007	.298	.000	.001
	UNDECIDEDMAJOR	.039	.496	.171	.005	.000	.006
	OTHERETHNIC	.049	.000	.000	.256	.251	.065
	WHITE	.002	.000	.000	.031	.306	.097
	BLACK	.	.012	.001	.000	.433	.004
	HISPANIC	.012	.	.000	.017	.000	.224
	ASIAN	.001	.000	.	.016	.000	.187
	AGE	.000	.017	.016	.	.005	.321
	COURSEMAJORMIX	.433	.000	.000	.005	.	.002
	MATESCORE	.004	.224	.187	.321	.002	.
N	ISEASCORE	867	867	867	867	867	867

	MosartTOTAL	867	867	867	867	867	867
	NOSSCORE	867	867	867	867	867	867
	biomajor	867	867	867	867	867	867
	BIORELATEDMAJOR	867	867	867	867	867	867
	SCIENCEMAJOR	867	867	867	867	867	867
	NONSCIENCEMAJOR	867	867	867	867	867	867
	UNDECIDEDMAJOR	867	867	867	867	867	867
	OTHERETHNIC	867	867	867	867	867	867
	WHITE	867	867	867	867	867	867
	BLACK	867	867	867	867	867	867
	HISPANIC	867	867	867	867	867	867
	ASIAN	867	867	867	867	867	867
	AGE	867	867	867	867	867	867
	COURSEMAJORMIX	867	867	867	867	867	867
	MATESCORE	867	867	867	867	867	867

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	MATESCORE, AGE, biomajor, OTHERETHNIC, SCIENCEMAJOR, BLACK, COURSEMAJORMIX, HISPANIC, UNDECIDEDMAJOR, NOSSCORE, WHITE, MosartTOTAL, NONSCIENCEMAJOR	.	Enter

a. Tolerance = .000 limits reached.

b. Dependent Variable: ISEASCORE

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.818[a]	.669	.664	4.166

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.818[a]	.669	.664	4.166

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	29910.591	13	2300.815	132.587	.000[a]
	Residual	14802.308	853	17.353		
	Total	44712.900	866			

Coefficients[a]

Model		Unstandardized Coefficients	
		B	Std. Error
1	(Constant)	-2.603	1.103
	MosartTOTAL	-.080	.070
	NOSSCORE	-.130	.065
	biomajor	.474	.491
	SCIENCEMAJOR	-.444	.429
	NONSCIENCEMAJOR	-.067	.426
	UNDECIDEDMAJOR	.668	.475
	OTHERETHNIC	-1.090	.468
	WHITE	-.799	.362
	BLACK	.977	1.042
	HISPANIC	-.046	.400
	AGE	-.117	.203
	COURSEMAJORMIX	.168	.328
	MATESCORE	.452	.013

Coefficients[a]

Model		Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	Upper Bound
1	(Constant)		-2.358	.019	-4.768	-.437
	MosartTOTAL	-.027	-1.134	.257	-.218	.058
	NOSSCORE	-.046	-1.992	.047	-.259	-.002
	biomajor	.021	.965	.335	-.490	1.438
	SCIENCEMAJOR	-.024	-1.035	.301	-1.285	.398
	NONSCIENCEMAJOR	-.004	-.158	.874	-.903	.769
	UNDECIDEDMAJOR	.033	1.405	.160	-.265	1.600
	OTHERETHNIC	-.051	-2.328	.020	-2.009	-.171
	WHITE	-.051	-2.210	.027	-1.509	-.089
	BLACK	.019	.938	.349	-1.068	3.022
	HISPANIC	-.003	-.116	.908	-.832	.740
	AGE	-.012	-.574	.566	-.516	.282
	COURSEMAJORMIX	.012	.513	.608	-.475	.812
	MATESCORE	.860	33.837	.000	.426	.478

Coefficients[a]

Model		Correlations Zero-order	Partial	Part	Collinearity Statistics Tolerance	VIF
1	(Constant)					
	MosartTOTAL	.408	-.039	-.022	.675	1.481
	NOSSCORE	.358	-.068	-.039	.724	1.382
	biomajor	.031	.033	.019	.806	1.241
	SCIENCEMAJOR	-.007	-.035	-.020	.703	1.422
	NONSCIENCEMAJOR	-.086	-.005	-.003	.595	1.680
	UNDECIDEDMAJOR	-.031	.048	.028	.718	1.392
	OTHERETHNIC	.005	-.079	-.046	.811	1.233
	WHITE	-.008	-.075	-.044	.724	1.381
	BLACK	-.049	.032	.018	.907	1.103
	HISPANIC	.008	-.004	-.002	.738	1.356
	AGE	-.006	-.020	-.011	.937	1.067
	COURSEMAJORMIX	-.066	.018	.010	.771	1.298
	MATESCORE	.812	.757	.667	.601	1.664

a. Dependent Variable: ISEASCORE

Excluded Variables[b]

Model		Beta In	t	Sig.	Partial Correlation
1	BIORELATEDMAJOR	.[a]	.	.	.
	ASIAN	.[a]	.	.	.

Excluded Variables[b]

Model		Collinearity Statistics		
		Tolerance	VIF	Minimum Tolerance
1	BIORELATEDMAJOR	.000	.	.000
	ASIAN	.000	.	.000

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index
1	1	6.213	1.000
	2	1.142	2.332
	3	1.127	2.348
	4	1.025	2.462
	5	1.011	2.479
	6	.951	2.556
	7	.901	2.626
	8	.631	3.138
	9	.377	4.058
	10	.291	4.621
	11	.209	5.448
	12	.098	7.962
	13	.013	21.623
	14	.011	24.071

Collinearity Diagnostics[a]

Model	Dimension	Variance Proportions				
		(Constant)	MosartTOTAL	NOSSCORE	biomajor	SCIENCEMAJOR
1	1	.00	.00	.00	.00	.00
	2	.00	.00	.00	.01	.00
	3	.00	.00	.00	.19	.00
	4	.00	.00	.00	.05	.03
	5	.00	.00	.00	.00	.33
	6	.00	.00	.00	.29	.03
	7	.00	.00	.00	.01	.00
	8	.00	.00	.00	.03	.04
	9	.00	.08	.00	.19	.10
	10	.00	.02	.00	.04	.02
	11	.00	.01	.00	.12	.41
	12	.03	.73	.03	.05	.03
	13	.02	.07	.47	.00	.00
	14	.95	.09	.50	.01	.01

Collinearity Diagnostics[a]

Model	Dimension	Variance Proportions				
		NONSCIENCEMAJOR	UNDECIDEDMAJOR	OTHERETHNIC	WHITE	BLACK
1	1	.00	.00	.00	.00	.00
	2	.02	.13	.03	.01	.32
	3	.09	.00	.09	.01	.01
	4	.01	.01	.18	.14	.21
	5	.06	.11	.03	.00	.02
	6	.00	.03	.00	.09	.00
	7	.10	.21	.25	.00	.12
	8	.00	.00	.00	.00	.20
	9	.02	.06	.01	.02	.01
	10	.02	.01	.36	.69	.09
	11	.62	.36	.00	.00	.00
	12	.04	.03	.04	.02	.01
	13	.00	.00	.00	.00	.00
	14	.02	.03	.00	.00	.00

Collinearity Diagnostics[a]

Model	Dimension	Variance Proportions			
		HISPANIC	AGE	COURSEMAJOR MIX	MATESCORE
1	1	.00	.01	.01	.00
	2	.03	.07	.00	.00
	3	.10	.01	.02	.00
	4	.00	.02	.00	.00
	5	.02	.00	.00	.00
	6	.19	.01	.00	.00
	7	.02	.01	.00	.00
	8	.03	.77	.02	.00
	9	.00	.08	.28	.00
	10	.54	.02	.05	.00
	11	.00	.00	.59	.00
	12	.05	.01	.03	.01
	13	.00	.00	.00	.86
	14	.00	.00	.01	.13

Casewise Diagnostics[a]

Case Number	Std. Residual	ISEASCORE	Predicted Value	Residual
1	3.942	40	23.58	16.421
164	-3.023	19	31.59	-12.593
217	-4.099	15	32.07	-17.074
582	-5.180	8	29.58	-21.578
584	3.168	40	26.80	13.197
585	-3.610	14	29.04	-15.038
588	-3.137	14	27.07	-13.066
617	-3.062	19	31.75	-12.753

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	11.64	40.16	29.60	5.877	867
Std. Predicted Value	-3.055	1.798	.000	1.000	867
Standard Error of Predicted Value	.343	1.143	.517	.116	867
Adjusted Predicted Value	11.63	40.18	29.60	5.877	867
Residual	-21.578	16.421	.000	4.134	867
Std. Residual	-5.180	3.942	.000	.992	867
Stud. Residual	-5.217	3.978	.000	1.001	867
Deleted Residual	-21.884	16.726	-.001	4.203	867
Stud. Deleted Residual	-5.299	4.013	.000	1.003	867
Mahal. Distance	4.867	64.187	12.985	7.884	867
Cook's Distance	.000	.028	.001	.002	867
Centered Leverage Value	.006	.074	.015	.009	867

a. Dependent Variable: ISEASCORE

Appendix F: Multiple Regression Data for Prediction of I-SEA Score with All Variables Except MATE Scores

Descriptive Statistics

	Mean	Std. Deviation	N
ISEASCORE	29.60	7.186	867
MosartTOTAL	5.05	2.450	867
NOSSCORE	15.93	2.542	867
biomajor	.1165	.32100	867
BIORELATEDMAJOR	.3022	.45947	867
SCIENCEMAJOR	.1915	.39368	867
NONSCIENCEMAJOR	.2457	.43074	867
UNDECIDEDMAJOR	.1442	.35147	867
OTHERETHNIC	.1292	.33559	867
WHITE	.3033	.45997	867
BLACK	.0208	.14267	867
HISPANIC	.2157	.41153	867
ASIAN	.3310	.47085	867
AGE	.4406	.71900	867
COURSEMAJORMIX	.5917	.49180	867

Correlations

		ISEASCORE	Mosart TOTAL	NOS SCORE	Bio major	BIORELATED MAJOR
Pearson Correlation	ISEASCORE	1.000	.408	.358	.031	.089
	MosartTOTAL	.408	1.000	.378	-.019	.107
	NOSSCORE	.358	.378	1.000	.025	.094
	biomajor	.031	-.019	.025	1.000	-.239
	BIORELATEDMAJOR	.089	.107	.094	-.239	1.000
	SCIENCEMAJOR	-.007	.012	.046	-.177	-.320
	NONSCIENCEMAJOR	-.086	-.084	-.078	-.207	-.376
	UNDECIDEDMAJOR	-.031	-.033	-.102	-.149	-.270
	OTHERETHNIC	.005	-.021	.063	.021	.016
	WHITE	-.008	.102	.062	.050	-.063
	BLACK	-.049	-.075	-.050	-.002	-.008
	HISPANIC	.008	-.114	-.073	-.033	-.076
	ASIAN	.012	.038	-.027	-.034	.119
	AGE	-.006	.008	.053	-.003	.065
	COURSEMAJORMIX	-.066	-.125	-.116	-.181	-.337
Sig. (1-tailed)	ISEASCORE	.	.000	.000	.181	.005
	MosartTOTAL	.000	.	.000	.291	.001

	NOSSCORE	.000	.000	.	.231	.003
	biomajor	.181	.291	.231	.	.000
	BIORELATEDMAJOR	.005	.001	.003	.000	.
	SCIENCEMAJOR	.415	.360	.088	.000	.000
	NONSCIENCEMAJOR	.006	.006	.011	.000	.000
	UNDECIDEDMAJOR	.182	.163	.001	.000	.000
	OTHERETHNIC	.442	.264	.032	.269	.318
	WHITE	.405	.001	.033	.072	.032
	BLACK	.074	.013	.069	.471	.410
	HISPANIC	.402	.000	.016	.165	.012
	ASIAN	.362	.129	.212	.160	.000
	AGE	.434	.402	.059	.471	.028
	COURSEMAJORMIX	.026	.000	.000	.000	.000
N	ISEASCORE	867	867	867	867	867
	MosartTOTAL	867	867	867	867	867
	NOSSCORE	867	867	867	867	867
	biomajor	867	867	867	867	867
	BIORELATEDMAJOR	867	867	867	867	867
	SCIENCEMAJOR	867	867	867	867	867
	NONSCIENCEMAJOR	867	867	867	867	867
	UNDECIDEDMAJOR	867	867	867	867	867
	OTHERETHNIC	867	867	867	867	867
	WHITE	867	867	867	867	867
	BLACK	867	867	867	867	867
	HISPANIC	867	867	867	867	867
	ASIAN	867	867	867	867	867
	AGE	867	867	867	867	867
	COURSEMAJORMIX	867	867	867	867	867

Correlations

		SCIENCE MAJOR	NONSCIENCE MAJOR	UNDECIDE DMAJOR	OTHER ETHNIC	WHITE
Pearson Correlation	ISEASCORE	-.007	-.086	-.031	.005	-.008
	MosartTOTAL	.012	-.084	-.033	-.021	.102
	NOSSCORE	.046	-.078	-.102	.063	.062
	biomajor	-.177	-.207	-.149	.021	.050
	BIORELATEDMAJOR	-.320	-.376	-.270	.016	-.063
	SCIENCEMAJOR	1.000	-.278	-.200	-.004	.010
	NONSCIENCE MAJOR	-.278	1.000	-.234	-.060	.055
	UNDECIDEDMAJOR	-.200	-.234	1.000	.038	-.042

	OTHERETHNIC	-.004	-.060	.038	1.000	-.254
	WHITE	.010	.055	-.042	-.254	1.000
	BLACK	-.009	.067	-.060	-.056	-.096
	HISPANIC	.051	.059	.000	-.202	-.346
	ASIAN	-.050	-.083	.032	-.271	-.464
	AGE	.024	-.018	-.087	.022	.063
	COURSEMAJORMIX	.082	.327	.114	-.023	.017
Sig. (1-tailed)	ISEASCORE	.415	.006	.182	.442	.405
	MosartTOTAL	.360	.006	.163	.264	.001
	NOSSCORE	.088	.011	.001	.032	.033
	biomajor	.000	.000	.000	.269	.072
	BIORELATEDMAJOR	.000	.000	.000	.318	.032
	SCIENCEMAJOR	.	.000	.000	.455	.379
	NONSCIENCEMAJOR	.000	.	.000	.039	.054
	UNDECIDEDMAJOR	.000	.000	.	.134	.107
	OTHERETHNIC	.455	.039	.134	.	.000
	WHITE	.379	.054	.107	.000	.
	BLACK	.394	.024	.039	.049	.002
	HISPANIC	.066	.041	.496	.000	.000
	ASIAN	.073	.007	.171	.000	.000
	AGE	.241	.298	.005	.256	.031
	COURSEMAJORMIX	.008	.000	.000	.251	.306
N	ISEASCORE	867	867	867	867	867
	MosartTOTAL	867	867	867	867	867
	NOSSCORE	867	867	867	867	867
	biomajor	867	867	867	867	867
	BIORELATEDMAJOR	867	867	867	867	867
	SCIENCEMAJOR	867	867	867	867	867
	NONSCIENCEMAJOR	867	867	867	867	867
	UNDECIDEDMAJOR	867	867	867	867	867
	OTHERETHNIC	867	867	867	867	867
	WHITE	867	867	867	867	867
	BLACK	867	867	867	867	867
	HISPANIC	867	867	867	867	867
	ASIAN	867	867	867	867	867
	AGE	867	867	867	867	867
	COURSEMAJORMIX	867	867	867	867	867

Correlations

		BLACK	HISPANIC	ASIAN	AGE	COURSE MAJORMIX
Pearson Correlation	ISEASCORE	-.049	.008	.012	-.006	-.066
	MosartTOTAL	-.075	-.114	.038	.008	-.125
	NOSSCORE	-.050	-.073	-.027	.053	-.116
	biomajor	-.002	-.033	-.034	-.003	-.181
	BIORELATEDMAJOR	-.008	-.076	.119	.065	-.337
	SCIENCEMAJOR	-.009	.051	-.050	.024	.082
	NONSCIENCEMAJOR	.067	.059	-.083	-.018	.327
	UNDECIDEDMAJOR	-.060	.000	.032	-.087	.114
	OTHERETHNIC	-.056	-.202	-.271	.022	-.023
	WHITE	-.096	-.346	-.464	.063	.017
	BLACK	1.000	-.076	-.102	.192	.006
	HISPANIC	-.076	1.000	-.369	-.072	.145
	ASIAN	-.102	-.369	1.000	-.073	-.129
	AGE	.192	-.072	-.073	1.000	-.088
	COURSEMAJORMIX	.006	.145	-.129	-.088	1.000
Sig. (1-tailed)	ISEASCORE	.074	.402	.362	.434	.026
	MosartTOTAL	.013	.000	.129	.402	.000
	NOSSCORE	.069	.016	.212	.059	.000
	biomajor	.471	.165	.160	.471	.000
	BIORELATEDMAJOR	.410	.012	.000	.028	.000
	SCIENCEMAJOR	.394	.066	.073	.241	.008
	NONSCIENCEMAJOR	.024	.041	.007	.298	.000
	UNDECIDEDMAJOR	.039	.496	.171	.005	.000
	OTHERETHNIC	.049	.000	.000	.256	.251
	WHITE	.002	.000	.000	.031	.306
	BLACK	.	.012	.001	.000	.433
	HISPANIC	.012	.	.000	.017	.000
	ASIAN	.001	.000	.	.016	.000
	AGE	.000	.017	.016	.	.005
	COURSEMAJORMIX	.433	.000	.000	.005	.
N	ISEASCORE	867	867	867	867	867
	MosartTOTAL	867	867	867	867	867
	NOSSCORE	867	867	867	867	867
	biomajor	867	867	867	867	867
	BIORELATEDMAJOR	867	867	867	867	867
	SCIENCEMAJOR	867	867	867	867	867
	NONSCIENCEMAJOR	867	867	867	867	867
	UNDECIDEDMAJOR	867	867	867	867	867

OTHERETHNIC	867	867	867	867	867
WHITE	867	867	867	867	867
BLACK	867	867	867	867	867
HISPANIC	867	867	867	867	867
ASIAN	867	867	867	867	867
AGE	867	867	867	867	867
COURSEMAJORMIX	867	867	867	867	867

Variables Entered/Removed[b]

Model	Variables Entered	Variables Removed	Method
1	COURSEMAJORMIX, BLACK, OTHERETHNIC, SCIENCEMAJOR, NOSSCORE, AGE, biomajor, HISPANIC, UNDECIDEDMAJOR, MosartTOTAL, WHITE, NONSCIENCEMAJOR	.	Enter

a. Tolerance = .000 limits reached.
b. Dependent Variable: ISEASCORE

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.474[a]	.225	.214	6.372

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10042.323	12	836.860	20.613	.000[a]
	Residual	34670.577	854	40.598		
	Total	44712.900	866			

Coefficients[a]

Model		Unstandardized Coefficients B	Std. Error
1	(Constant)	14.342	1.504
	MosartTOTAL	.951	.097
	NOSSCORE	.676	.093
	biomajor	.319	.751
	SCIENCEMAJOR	-.840	.656
	NONSCIENCEMAJOR	-1.064	.650
	UNDECIDEDMAJOR	-.479	.725
	OTHERETHNIC	-.124	.715
	WHITE	-.602	.553
	BLACK	-.402	1.593
	HISPANIC	.872	.611
	AGE	-.134	.311
	COURSEMAJORMIX	.352	.501

Coefficients[a]

Model		Standardized Coefficients Beta	t	Sig.	95.0% Confidence Interval for B Lower Bound	Upper Bound
1	(Constant)		9.536	.000	11.390	17.294
	MosartTOTAL	.324	9.815	.000	.761	1.142
	NOSSCORE	.239	7.253	.000	.493	.859
	biomajor	.014	.425	.671	-1.156	1.794
	SCIENCEMAJOR	-.046	-1.281	.200	-2.127	.447
	NONSCIENCEMAJOR	-.064	-1.637	.102	-2.340	.212
	UNDECIDEDMAJOR	-.023	-.661	.509	-1.902	.944
	OTHERETHNIC	-.006	-.174	.862	-1.528	1.279
	WHITE	-.039	-1.088	.277	-1.687	.484
	BLACK	-.008	-.252	.801	-3.528	2.724
	HISPANIC	.050	1.427	.154	-.327	2.072
	AGE	-.013	-.430	.667	-.744	.477
	COURSEMAJORMIX	.024	.703	.482	-.632	1.337

Coefficients[a]

Model		Correlations			Collinearity Statistics	
		Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)					
	MosartTOTAL	.408	.318	.296	.831	1.203
	NOSSCORE	.358	.241	.219	.834	1.199
	biomajor	.031	.015	.013	.806	1.241
	SCIENCEMAJOR	-.007	-.044	-.039	.704	1.421
	NONSCIENCEMAJOR	-.086	-.056	-.049	.598	1.672
	UNDECIDEDMAJOR	-.031	-.023	-.020	.722	1.385
	OTHERETHNIC	.005	-.006	-.005	.814	1.228
	WHITE	-.008	-.037	-.033	.724	1.381
	BLACK	-.049	-.009	-.008	.908	1.101
	HISPANIC	.008	.049	.043	.741	1.349
	AGE	-.006	-.015	-.013	.937	1.067
	COURSEMAJORMIX	-.066	.024	.021	.771	1.297

Excluded Variables[b]

Model		Beta In	t	Sig.	Partial Correlation
1	BIORELATEDMAJOR	.[a]	.	.	.
	ASIAN	.[a]	.	.	.

Excluded Variables[b]

Model		Collinearity Statistics		
		Tolerance	VIF	Minimum Tolerance
1	BIORELATEDMAJOR	.000	.	.000
	ASIAN	.000	.	.000

Collinearity Diagnostics[a]

Model	Dimension	Eigenvalue	Condition Index
1	1	5.268	1.000
	2	1.141	2.149
	3	1.124	2.164
	4	1.025	2.268
	5	1.011	2.283
	6	.951	2.354
	7	.901	2.418
	8	.630	2.891
	9	.351	3.872
	10	.288	4.278
	11	.209	5.022
	12	.090	7.653
	13	.011	21.889

Collinearity Diagnostics[a]

Model	Dimension	Variance Proportions				
		(Constant)	MosartTOTAL	NOSSCORE	biomajor	SCIENCEMAJOR
1	1	.00	.00	.00	.00	.00
	2	.00	.00	.00	.03	.00
	3	.00	.00	.00	.18	.00
	4	.00	.00	.00	.05	.03
	5	.00	.00	.00	.00	.33
	6	.00	.00	.00	.29	.03
	7	.00	.00	.00	.01	.00
	8	.00	.00	.00	.03	.04
	9	.00	.13	.00	.18	.09
	10	.00	.04	.00	.03	.02
	11	.00	.01	.00	.12	.41
	12	.06	.76	.05	.06	.04
	13	.93	.04	.94	.01	.00

Collinearity Diagnostics[a]

Model	Dimension	Variance Proportions				
		NONSCIENCEMAJOR	UNDECIDEDMAJOR	OTHERETHNIC	WHITE	BLACK
1	1	.00	.00	.00	.01	.00
	2	.01	.13	.02	.02	.31
	3	.10	.01	.11	.01	.02
	4	.01	.01	.18	.14	.21
	5	.06	.11	.03	.00	.03
	6	.00	.03	.00	.09	.00
	7	.10	.21	.25	.00	.12
	8	.00	.00	.00	.00	.20
	9	.02	.05	.00	.00	.01
	10	.02	.00	.36	.70	.08
	11	.62	.37	.00	.00	.00
	12	.05	.04	.04	.02	.01
	13	.01	.02	.00	.00	.00

Collinearity Diagnostics[a]

Model	Dimension	Variance Proportions		
		HISPANIC	AGE	COURSEMAJORMIX
1	1	.00	.01	.01
	2	.04	.07	.00
	3	.09	.01	.01
	4	.00	.02	.00
	5	.02	.00	.00
	6	.20	.01	.00
	7	.02	.01	.00
	8	.03	.76	.02
	9	.01	.10	.31
	10	.52	.01	.02
	11	.00	.00	.58
	12	.06	.02	.03
	13	.00	.00	.01

Case Number	Std. Residual	ISEASCORE	Predicted Value	Residual
4	-3.250	8	28.71	-20.707
15	-3.294	10	30.99	-20.988
16	-3.421	11	32.80	-21.798
582	-3.101	8	27.76	-19.757
593	-3.636	13	36.17	-23.168

a. Dependent Variable: ISEASCORE

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	20.17	38.12	29.60	3.405	867
Std. Predicted Value	-2.768	2.503	.000	1.000	867
Standard Error of Predicted Value	.522	1.721	.760	.175	867
Adjusted Predicted Value	20.28	38.09	29.59	3.409	867
Residual	-23.168	17.562	.000	6.327	867
Std. Residual	-3.636	2.756	.000	.993	867
Stud. Residual	-3.670	2.782	.000	1.001	867
Deleted Residual	-23.598	17.887	.001	6.425	867
Stud. Deleted Residual	-3.697	2.793	.000	1.002	867
Mahal. Distance	4.820	62.175	11.986	7.693	867
Cook's Distance	.000	.027	.001	.002	867
Centered Leverage Value	.006	.072	.014	.009	867

a. Dependent Variable: ISEASCORE

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