STEM TRENDS IN HIGHER EDUCATION:
A COMPARATIVE STUDY OF STUDENT ATTITUDES AS PERSISTENCE FACTORS
AMONG BIOLOGY MAJORS

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Aaron Roth

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ABSTRACT

Students who feel that Biology is important for them to achieve their career or professional school goals are more likely to persist. While students entering college as premed vs. non-premed persisted at the same rate, those who changed their mind about med school were more likely to switch to another major. The purpose of this research study was to investigate the role that student attitudes play in persistence among Biology majors. This study utilized Expectancy-Value Theory as a theoretical framework. This theory is founded in evidence that student’s choice, persistence, and performance is linked to their beliefs about how well they will perform within a subject of study and how much they value the subject. The research questions that guided this study are as follows. Is persistence within the Biology major correlated to student task-value beliefs and academic self-concept as defined by expectancy-value theory? Is there a difference in persistence rates among Biology students who express premed intentions and those who do not intend to apply to medical school? Do students who express intentions to apply to medical school within the biology major exhibit higher task-value scores in the Student Attitude Questionnaire (SAQ) than students within the biology major who do not express premedical intentions? What are the key triggers for persistence in students in Biology? This quantitative research study was conducted within the Biology Department at Northeastern University and its target population was students who entered the university as Biology majors within the past five years. The target population included both pre-med and non-premed students who entered their freshman year as Biology majors. Data was collected from existing enrollment data and subsequent questionnaires and was analyzed to determine if students who declare there intention to apply to medical school upon entering college are more likely to persist within the biology major than those who do not. The Student Attitude questionnaire (SAQ) was utilized to measure
student attitudes, anxiety levels, and achievement. Specifically, this questionnaire is designed to measure ability belief variables, expectancy variables, and value variables. Persisters were sampled during their biology Capstone course. Switchers were contacted via email and asked to participate in the SAQ via Surveymonkey.com. There was no difference between switchers and persisters according to self-concept variables (except for confidence in lab courses). This finding contradicts previous studies that have shown self-concept to have a great impact on persistence. Results indicate that value measures in the form of professional aspirations are the most important factor influencing persistence in biology. Students who left the biology major exhibited a lack of knowledge of available career paths within the discipline, often stating their belief that a biology degree was only useful for entrance into medical school or a career in lab-based research. This suggests that biology departments should do a better job of promoting alternate careers in biology.
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CHAPTER ONE: INTRODUCTION

Statement of the Problem

Student persistence in the sciences has become a critical issue. Green (1989) points out that “not only do the sciences have the highest defection rates of any undergraduate major, they also have the lowest rated of recruitment from any other major” (p. 478). The number of students recruited into science majors and then retained until graduation is too low to meet the needs of the nation (Seymour & Hewitt, 1997; Boe et al., 2010; Shedlosky-Shoemaker & Fautch, 2015). Data indicates that the number of students completing degrees in STEM fields has been declining since the 1980’s (Seymour & Hewitt, 1997; Anderson & Ward, 2014; Shedlosky-Shoemaker & Fautch, 2015). Among students who enroll as science majors, roughly 50 percent will change their major to a non-science major at the end of their freshman year, indicating that persistence in non-STEM fields is much higher than in the STEM fields (Shedlosky-Shoemaker & Fautch, 2015). However, the rate of attrition drops to two percent at the completion of the sophomore year and 0.8 percent at the conclusion of the junior year (Hilton & Lee, 1988). Because of this fact, most studies of attrition have been limited to first-year students, leaving Hilton and Lee’s 1988 study as the most recent published data on the subject. Studies of student persistence in the sciences have focused on factors such as quality of curriculum (Seymour & Hewitt, 1997), teacher attitude and effectiveness (Strenta, 1994), quality of secondary education (Daempfle, 2003-2004), poor preparation in high school (Razali & Yager, 1994), race (Rath, et al., 2006), gender (Fenske, et al., 2000), and financial aid (Rayman & Brett, 1995). However, the importance of student beliefs and intentions on success and persistence within the sciences has been understudied (Lang, 2008). The current study focuses on student self-efficacy and attitudes toward biology and their influence on persistence within the biology major throughout a 4-5 year college experience. This study further examines...
differences in attitudes and persistence between biology majors who intend to apply to medical school (premed) and those who do not.

**Significance of the Problem**

This problem of student attrition is important, as failure to address attrition rates will have consequences. Attrition affects the student who has failed, the institution that has invested in the student, and the community surrounding the school (Seidman, 2005). For the student, any debt incurred while attending college must be repaid even though the degree, and the associated increased earning potential, was not earned. For the school, attrition means a loss of future tuition dollars, making any resources invested in recruitment a loss. The community surrounding the school will suffer a loss as there will be fewer students spending money at local businesses. Finally, there is a national economic impact resulting from a workforce that has not received appropriate training to attain careers in an increasingly technical job market (TIMMS, 2011).

This problem also represents a perpetuation of social inequities. College graduates enjoy greater job attainment, greater earning potential, suffer fewer health problems, are less likely to be incarcerated, and live longer than non-college graduates (Seidman, 2005). In addition, due to increases in tuition and fees, the federal government has become more invested in higher education through federal financial aid programs. The hope is that money invested in financial aid will be reinvested in the economy when a college graduate enters the workforce (Seidman, 2005). High attrition rates will bring government scrutiny to higher education as it will want to know if its money is being spent effectively. As Seidman (2005) points out: “government agencies want to be sure that the money they are investing in higher education is producing results, that is, that those receiving the aid were receiving an education that would help them get
jobs and put money back into governmental coffers through taxes” (p. 9). Finally, if educational institutions are not able to retain students, they are failing in their academic mission. This could have significant impact on public perception and support, potentially turning students away from four-year institutions in favor of more non-traditional educational models.

**Research Questions**

This research study investigates the following research questions.

Question 1: Is persistence within the Biology major correlated to student task-value beliefs and academic self-concept as defined by expectancy-value theory?

Hypothesis 1: There is a correlation between expectancy-value measures and persistence among biology majors.

Question 2: Is there a difference in persistence rates among biology students who express premed intentions and those who do not intend to apply to medical school?

Hypothesis 2: There is a significant difference in persistence rates between premed and non-premed biology majors.

Question 3: Do students who express intentions to apply to medical school within the biology major exhibit higher task-value scores in the Student Attitude Questionnaire (SAQ) than students within the biology major who do not express premedical intentions?

Hypothesis 3: Pre-med students will exhibit lower scores on the SAQ than non-premed students.
Question 4: What are the key triggers for persistence in biology? This open-ended question will provide context to compliment the quantitative data.

**Theoretical Framework**

This study utilized Expectancy-Value Theory (Atkinson, 1957) as a theoretical framework. This theory is founded in evidence that student’s choice, persistence, and performance is linked to their beliefs about how well they will perform within a subject of study and how much they value the subject (Atkinson, 1957; Eccles Et al., 1983, Wigfield & Cambria, 2010). According to Guo Et al. (2015), tasks-value beliefs and academic self-concept directly influence achievement choices, performance, effort, and persistence within the STEM field of mathematics. Therefore, students who value a subject and exhibit strong belief in their ability to succeed in an academic task will exhibit a higher rate of academic success than students who do not have such beliefs.
These beliefs are tied to expectations of success, which have also shown to positively correlate to academic success (Meece, Et al., 1990). Further, studies of student self-efficacy have shown that measures of ability beliefs relate closely with behavior (Bandura, 1997). Within this theoretical framework, beliefs and expectations both influence student success and behavior and must be distinguished from each other so that they may be treated as separate variables. Wigfield and Eccles (2000) conceptually distinguish beliefs from expectancies for success “with ability beliefs focused on present ability and expectancies focused on the future. The final variable within the Expectancy-Value theory is value. Students are expected to expend more effort on an academic task, and exhibit higher persistence within a subject if they value that task/subject highly (Eccles & Wigfield, 1995). There are numerous studies that have found a link between expectancy and academic persistence within STEM (Besterfield-Sacre Et al., 1997; Marra Et al., 2009; Anderson & Ward, 2014; Perez Et al., 2014; Shedlosky-Shoemaker & Fautch, 2015). These studies found that students who lacked confidence in their ability to succeed in a STEM major were less likely
to persist within STEM. Further, these studies concluded that student self-concept was a critical factor in persistence.

**Summary of Terms**

Biology Major – an undergraduate student majoring in biology or one of three biology-combined majors (Biochemistry, Behavioral Neuroscience, Marine Biology)

Expectancy-Value Theory – the theoretical framework of this study. Theorizes that student’s choice, persistence, and performance is linked to student self-concept and how much value is placed on the subject.

NU – Northeastern University

Non-premed – a student who does not intend to apply to medical school

Persister – a student who remains a biology major until graduation

Premed – a student intending to apply to medical school before or after graduation

STEM – science, technology, engineering, and math disciplines

SAQ – Student Attitude Questionnaire

SES – socioeconomic status

Switcher – a student who leaves the biology major before graduation
CHAPTER 2: LITERATURE REVIEW

In chapter 1, the focus of this research study was introduced. The problem of attrition in the sciences was defined and its significance discussed. The theoretical framework of the Expectancy-Value theory was defined and the research questions identified. The current chapter will provide an overview of literature focusing on student retention in the sciences and in general.

Attrition in the Sciences

Seymour and Hewitt (1997) studied the factors affect attrition rates among STEM college students enrolled at various institutions. From their findings, they formulated the “Chilly Climate Hypothesis” of STEM persistence. This hypothesis was born from concerns from both students who left science majors and those who persisted about the quality of teaching in the science and the commitment of science faculty to teaching. Daempfle (2003-2004) summarized their findings: “nine out of ten switchers and three our of four persisters described the quality of science teaching as poor overall. Concerns about the pedagogical effectiveness, assessment factors and curricular structure appeared in all issues raised. The results showed that students strongly believed that faculty did not like to teach, did not value teaching as a professional activity, and valued their research above teaching” (p. 39). Terms to describe faculty during the study included “unapproachable,” “cold,” unavailable,” “aloof,” “indifferent,” and “intimidating” (Seymour & Hewitt, 1997). Further, students were dissatisfied with the one-way lecture style classes in the sciences that did not allow for any open discussion of the topics (Seymour & Hewitt, 1997).
Attrition rates among students at colleges and universities have long been a subject of concern and study. This attrition rate has taken on greater urgency as society has become more ethnically and racially diverse. In response to these demographic changes, higher education institutions have sought to recruit a more diverse student body that reflects society as a whole (Sutherland, Et al., 2007). Consequently, the factors affecting attrition rates have become more complex and difficult to study. This is a matter of concern as research shows that minority students are more likely to drop out of college than their non-minority counterparts (Elmers & Pike, 1997). If the factors contributing to the increased attrition rate among minority students are not clearly understood, it is impossible to develop effective intervention programs with which to increase retention and maximize student success.

This is crucial to the academic and business mission of any university as the ability to identify and aid students at risk of academic difficulty is essential to retention in higher education institutions, especially given the resources that institutions invest in recruitment. Student recruitment is a very costly endeavor. Advertising, open houses, admissions office staffs, recruiters, campus tour guides, and other tools of student recruitment all cost money and time. It is imperative that institutions see an appropriate return on this investment. In other words, it is important to the students that the institution spent so much money to acquire stay enrolled in the school for the entirety of their 3 to 5 year undergraduate careers. Any recruited student should represent multiple years of tuition income. Students who are lost after a year or two represent lost income to the institution and a poor return on the recruiting investment. Because of this any resources invested in a mentoring program should theoretically provide significant returns to the university in the form of tuition retained from current students who would have otherwise been forced to leave the school due to academic difficulty. Investigation
is necessary to determine if this benefit is quantifiable and how best to determine what this financial gain actually is.

The use of peer mentoring as a retention tool within universities and colleges has traditionally been seen as an effective tool to increase student success and retention (Terrion and Leonard, 2007). Mentoring aids students as they enter the world of higher education, which can be overwhelming for first year college students. College freshmen encounter higher pressures and workloads than they are likely to have ever experienced before. The demands on their time for both academic work and new social pressures put first year college students in a very precarious situation that they may be ill equipped to handle on their own. The thesis that guides this literature review is that student attrition is the result of multiple factors (academic, social, familial, cultural, and financial) and that there is no standard overriding factor that affects persistence for all groups. However, it is theorized that a well constructed and managed peer mentoring program is an effective tool for increasing student retention and promoting intellectual development of both mentees and mentors.

**The History Of Persistence Research**

Persistence has been a subject of study for over one hundred years, however detailed research did not start until after World War II (Seidman, 2005). The first widely accepted model for analyzing and predicting persistence was published in 1971, when Spady proposed that personal attributes interacted with environmental influences to affect retention. According to Spady (1971), positive interaction between personal attributes and environmental factors will provide students opportunities to successfully assimilate into the social and academic settings of an institution. Students who find rewards in this assimilation will be more likely to remain
enrolled (Terenzini & Pascarella, 1977). The next contribution was made in 1975 when Tinto proposed the Student Integration Model. This model proposes that the sociological interaction between student and institution was the greatest influence on persistence. In this model, precollege characteristics are of critical importance to retention. Factors such as family background, prior schooling, and previous skills will form the academic goals and commitments of a student (Tinto, 1975). Positive experiences in relation to the institution will strengthen the intentions and commitments of a student. “Intentions can include wanting a degree in a particular field of study, while commitment is the student’s desire to complete that degree and willingness to spend the time and energy necessary to obtain it” (Seidman, 2005, p. 10). In this way, retention is directly correlated with the level of integration by the student into the social and academic systems of the institution. Tinto explained his theory thusly: “persistence requires that individuals make the transition to college and become incorporated into the ongoing social and intellectual life of the college. A sizable proportion of very early institutional departures mirror the inability of new students to make the adjustment to the new world of the college. Beyond the transition to college, persistence entails the incorporation, which is integration, of the individual as a competent member in the social and intellectual communities of the college” (Tinto, 1987, p. 126). Further, he states: “Student institutional departure is as much a reflection of the attributes of those communities, and therefore of the institution, as it is of the attributes of the students who enter that institution. It is the daily interaction of the person with other members of the college in both the formal and informal academic and social domains of the college and the person’s perception or evaluation of the character of those interactions that in large measure determine decisions as to staying or leaving” (Tinto, 1987, p. 127).
Tinto’s Integration model was supported by the work of Terenzini and Wright (1987). Their study focused the measurable correlation between academic and social integration and academic skills spanning four years. They discovered that the critical time for integration was during the first year. Positive integration in the first year was a direct indicator of positive integration in subsequent years (Terenzini & Wright, 1987). It is logical that precollege factors would have greatest influence during the first year of college enrollment and that subsequent integration would lessen such an influence.

Astin (1985) also built upon the work of Tinto in his study of student involvement. Astin studied student involvement by evaluating the amount physical and psychological energy exerted by students towards academic activities. Students who devoted more energy towards such activities as studying, student organizations, and interactions with faculty exhibited a higher degree of commitment to the institution and therefore were more likely to continue enrollment. Astin (1985) recommends that institutions should promote integration early in a student’s career. Any activity that promotes goals and integration through positive interaction with the institution should be promoted as an effective retention tool.

The work of Terenzini and Wright (1987) and Astin (1985) focused on traditional students who likely resided within the dormitory system of their institution(s). The feasibility of their approach is problematic for non-traditional, commuter, and distance-learning students. Blustein et al (1986) studied commuter students at a community college and determined: “Enhancement of the academic integration of commuter students and other non-traditional students whose actual contact with the institution is minimal may be achieved by improving study skill, focusing on educational goals as a means of personal and vocational fulfillment, and helping students to gain the skill needed to interact in an academic setting” (Blustein, Et al.,
1986, p. 248). In other words, in the absence of integration through interaction, institutions should focus on goal-building exercises. According to Seidman, in such cases: “a clear connection between poor career and academic counseling, no defined career goal, and student attrition can be established. Colleges should take the early clarification of student educational goals seriously. If a student applies and is accepted into college but is undeclared or undecided as to a career goal, the evidence is clear that strenuous efforts should be made early on to help this student explore and decide on career options” (Seidman, 2005, p. 15). Seidman calls such intervention “preventative maintenance to high attrition” (p. 15).

Witt and Handal (1984), synthesized the ideas of Student Integration into their Person-Environment Fit theory. In this theory integration is interpreted as “satisfaction,” and is linked to social environmental interactions. Their investigations into this theory led them to conclude that “environmental perceptions had the strongest relationship to each component of satisfaction, with personality and congruency significant but weaker in their relationship to satisfaction” (Witt & Handal, 1984, p. 507). This has two implications. First, this conclusion reinforces the importance of promoting student involvement and development early. Second, this conclusion suggests that institutions would be well served to recruit students that (who) are likely to be a match to the social system of the institution. This would make for an easier transition, more satisfied students, and higher retention.

**Analysis Of Persistence: Two Major Theories**

Persistence research has traditionally been guided by two theories. These theories are Tinto’s Student Integration Model and Bean’s Student Attrition Model (Cabrera, Et al., 1993).
Both theories have been extensively studied and validated, however some gaps have also been identified.

The Integration Model suggests a link between attrition and the relationship between a student and his/her school. According, to this theory, the greater the synergy between a student’s academic ability and motivation and the institution’s social and academic characteristics, the higher the persistence. This is because such a match will foster, within the student, a commitment to an educational goal and a commitment to the institution (Tinto, 1975). Therefor, the essence of the Student Integration Model is that persistence is directly correlated with fostering a goal-oriented approach to college with a high level of institutional commitment.

Research into the Student Integration Model has historically supported its use as a predictive model for student persistence. This is, however, generally limited to its use as a precollege predictor (Pascarella & Terenzini, 1980). In other words, This theory may help to predict which students are best suited for a particular school, however, it may not account for other factors that impact a student after matriculation. These factors are likely to be external to the institution and therefore outside the scope of the Student Integration Model and thus the theory is not able to control for these variables (Nora & Rendon, 1990). This would seem to limit the use of this model in studies of cultural, racial, familial or financial influences on retention, as these are considered outside influences. However, some researchers have found the Student Integration Model to be still be useful when studying these external factors (Cabrera, Et al., 1993). This may be due to the model’s ability to accurately measure internal factors, allowing researchers to examine the external factors as an independent variable.

More recent studies have cast some doubt on the Student Integration Model. Mannan (2007) found a strong negative relationship between social integration a persistence. This
finding was supported by Rienties Et al (2012). In both studies it was determined that academic integration was more crucial for persistence. It was theorized that dedicating time to social activities and extracurricular activities diverted time from academic pursuits. Without academic success, social integration was not enough to sustain persistence.

The Student Attrition Model is based in the theory that student beliefs and behaviors are shaped by institutional factors and external factors. These factors work together to shape student attitudes and attrition behaviors (Bean, 1983). Variables can be organized into three main categories; organizational, personal, and environmental. Together, these variables shape attitudes and intents of students, thereby influencing decisions about staying in school. Further investigation revealed that only a few environmental, personal, and organizational variables might be responsible for the majority of the variance in retention numbers and that non-intellectual factors, especially family approval and support may have the largest influence among all factors (Cabrera, Et al., 1993). Bean and Eaton (2000, 2005) updated the Student Attrition Model as the Psychological Model of College Student Retention. This updated theory focused on the effect of college environment on the psychological state of the student. Specifically, the theory applies to the level of stress a student experiences from his/her college environment and how that influences retention.

Studies have been conducted to compare and contrast these two theories. Hossler (1984) proposed similarities between the two theories in a few aspects. Both models propose that precollege factors will affect retention. In addition both models posit that a successful match between student and institution will yield greater retention and that such functions are the result of organization factors and student commitment to the school. There are, however, some key differences between the two models. The first is that the Student Attrition model places higher
emphasis on external factors than the Student Integration model does (Cabrera, Et al., 1993). The second difference is the role of academic performance. The Integration model considers persistence to be influenced by academic performance whereas the Attrition model considers academic performance to be an outcome of other factors with positive influence on retention (Cabrera, Et al., 1993). In other words, the Integration Model considers there to be a direct link between student performance and attrition while the Attrition Model considers academic performance to be the result of other factors that affect retention. In the final analysis, it can be asserted that the student Integration Model “appears to suggest that academic integration, social integration, institutional commitment and to some extent, commitment, exert the highest effects on persistence” (Cabrera, Et al., 1993, p. 126) while the Student Attrition Model “emphasizes the role of intent to persist, attitudes, institutional fit, and external factors in the form of family approval of institutional choice, friends’ encouragement to continue enrollment, finance attitudes, and perceptions about opportunity to transfer to other institutions on withdrawal decisions” (Cabrera, Et al., 1993, p. 126). Overlaps between these two models were studied by Cabrera and colleagues (Cabrera, Et al., 1992). Their work suggests that the two may be used to compliment each other as while the Student Integration Model was more successful in predicting student persistence that the Student Attrition Model, the Attrition Model was more successful in explaining any variance found. In addition, overlap was found in some of the constructs essential to both theories. Cabrera et al. found that “the construct of Institutional Fit and Quality in the Student Attrition Model and the construct of Institutional Commitment in the Student Integration Model can be regarded as manifestations of a single underlying factor” (Cabera, Et al., 1993, p. 126). The final analysis of these models is that they are useful when merged into a single integrated model. This approach takes advantage of the predictive success of the
Integration Model while acknowledging the importance of external factors inherent in the Attrition Model. In this way the Attrition Model may be used to fill the largest gap in the Integration Model as both Bean (1985) and Cabrera et al. (1993) found that external factors such as encouragement from family and friends are very significant influences on persistence. This is significant for enrollment managers tasked with increasing persistence. “Focusing on past behavior (actual withdrawal decisions) is futile. It stands to reason that intervention strategies must address those variables that can be manipulated and which have found to be the strongest predictors of predispositions to leave” (Cabrera, Et al., 1993, p. 136). This means that retention tools other than the traditional (financial aid, academic advising, etc.) may be necessary to address the influence of factors external to the university.

**Sociological Factors Influencing Persistence**

**The Effect Of Race On Persistence**

Beginning about twenty years ago, higher education institutions have intensified their efforts to recruit and enroll minority students through utilization of targeted marketing and financial commitments in the form of scholarships (Elmers & Pike, 1997). However, research has shown that minority students are more likely to drop out of college than their Caucasian counterparts (Elmers & Pike, 1997; Wang et al., 2015). Some studies suggest that African-American students are twice as likely to switch from the STEM field than their white classmates (National Academy of Sciences, 2011). Saenz and colleagues (1998) list the social, academic, and financial pressures that contribute to higher attrition rates among minorities. These include: “limited financial aid; heavier workloads; fewer college preparatory courses in high school; difficulty with the type of oral or written English skills required for academic success;
differences in learning and communication styles; less support from professors, family, and or friends; less familiarity with the college system; a greater sense of social isolation; and a foreign accent” (Saenz, Et al., 1998).

Studies of retention among African American in US colleges and Universities suggest that attrition among this student population is tied to socio-environmental factors as well as financial factors (Hong & Ho, 2005; TIMSS, 2011). Further, factors differ among African American men and women. For instance, Peltier et al (1999) found that the academic success of African American men was enhanced when they had African American roommates. However, the same study found that academic success of African American women was more likely to be enhanced when they roomed with academically successful students. Seidman (2005) summarizes some of the issues faced by African Americans pursuing higher education: “Some of these hurdles are low levels of parental support, limited resources to pay for college, low self-esteem, and low social expectations for going to college and completing a college degree” (Seidman, 2005, p. 16). Further many African American college students are first-generation college students and may lack a role model in educational endeavors (Seidman, 2005). Finally, there is evidence that financial considerations may affect retention among African Americans disproportionately in comparison to other groups (Landry, 2003).

Among Native Americans, cultural considerations play an important part in persistence. Landry (2003) found that there is a fear among Native Americans that formal, institutionalized education may lead to a loss of cultural connectivity, language, and family due pressure to assimilate into the culture of the school. Other research has show that “Native American students who enter college and are well grounded in their cultural traditions have greater chance of persisting to graduation than those who do not bring this foundation” (Seidman, 2005, p. 17).
Work by Peltier and colleagues (1999) found that Native American persistence was also tied to such factors as academic preparation, aspirations, performance and faculty interaction. They recommend early faculty interaction as a retention tool, in this case (Peltier, Et al., 1999).

Hispanic student persistence is affected by three main factors. These are: lack of academic preparation, lack of community to compensate for being away from family, lack of financial aid and lack of knowledge of how to acquire such aid (Walker & Schultz, 2001). In addition, many Hispanic students do not posses the cultural grounding to value the long-term benefits of degree completion therefor an quick acclimation into the cultural system of the institution is imperative (Landry, 2003). This lack of value also comes into play with the financial component to Hispanic retention. Students who do not understand the value of an advanced degree will be less willing to take on debt to pay for that degree (Seidman, 2005).

**Retention Among First-Generation Students**

Studies have indicated that first-generation students (students who’s parents did not graduate from college) represent a unique subset of college students. When compared to their peers, first-generation students are found to have lower SAT scores and high school GPAs (Reihl, 1994). In addition it had been found that first-generation students have poorer critical thinking skills and have less support from family in academic matters (Terenzini, Et al., 1996). Higher level of education among parents generally indicates a career in a higher paying profession, higher SES, and homes with more resources (TIMSS, 2011). Further, first-year students tend to be less social and have less interaction with peers and faculty than non-first year students (Nunez & Cuccaro-Alamin, 1998). This has results in three attributes of first-year students, which may have an effect on retention of such students. First, these students tend to be
less confident in their academic abilities (Reihl, 1994). This may lead to a lack of commitment towards achieving a degree, especially if the student encounters difficulty. Second, without strong family support, there is no encouragement to stay in school (Terenzini, Et al., 1996). Thirdly, because of the lack of social interaction, first-generation students are less likely to become invested in the institution and therefore less likely to stay. Information about the correlation between first-generation status and grades is less clear as some studies have shown a correlation between first-generation status and poor grades while other studies have found no correlation at all (Ishanti, 2003).

Retention And Financial Considerations

Student financial aid is viewed as critical to retention (St. John, 2000). Even Tinto, who had previously down-played the importance of financial considerations in attrition (Tinto, 1975), reconsidered this view in the face of new data (Tinto, 1987). According to St. John (2000): “this does not mean that social and academic integration processes are not important—indeed they are crucial, as well—however, students need to be able to afford to continue their enrollment” (p. 69). There have been three critical findings in the link between financial aid and persistence. First, before the 1990s, most research found that there was a positive correlation between student aid and retention (St. John, 2000). This combined with the fact that there believed to be adequate financial aid available to students, led to Tinto’s belief that financial considerations were not a significant factor in determining persistence (St. John, 2000). The second finding was that in the 1990s, the student financial situation changed. There was no longer enough student aid available to adequately promote persistence (Des Jardins, Et al., 2002). This was especially true for public institutions as studies during this period found that, “(1) grant aid was inadequate (or
negatively associated with persistence) in public colleges and (2) grant aid was adequate (and neutral of positively associated with persistence) in private colleges” (St. John, 2000, p. 69).

Third, it is known that students are aware of their financial constraints and this knowledge affects their decision making process when it comes to both college enrollment and persistence (St. John, 2000). In fact, financial considerations may affect both the academic and social experience in college (Cabrera, Et. al., 1993).

Factors Affecting Retention In The Sciences

Student persistence in the science has become a critical issue (TIMMS, 2011; Sheldsky-Shoemaker & Fautch, 2015). Green (1989) points out “not only do the sciences have the highest deflection rates of any undergraduate major, they also have the lowest rated of recruitment from any other major” (p. 478). The number of students recruited into science majors and then retained until graduation is too low to meet the needs of the nation (Seymour & Hewitt, 1997, TIMMS, 2011). Data indicates that first-year college student interest in science majors dropped from 11.5 percent in 1966 to 5.8 percent in 1988 (Seymour & Hewitt, 1997). This is significant as the period between the completion of high school and the completion of the first year of college is the key time for the loss of science students. It has been estimated that around forty percent of potential science students are lost to non-science majors during this time (Astin & Astin, 1993). This decline persisted through the 2000’s (TIMMS, 2011; Sheldosky-Shoemaker & Fautch, 2015). Other studies have found that among students who do enroll as science majors, 35 percent will change their major to a non-science major at the end of their freshman year (Seymour & Hewitt, 1997). However, this number drops to two percent at the completion of the
sophomore year and 0.8 percent at the conclusion of the junior year (Hilton & Lee, 1988). This reinforces the importance of the freshman year in retention of science students.

Seymour and Hewitt (1997) studied the factors affect attrition rates among college students enrolled at various institutions. From their findings, they formulated the “Chilly Climate Hypothesis.” This hypothesis was born from concerns from both students who left science majors and those who persisted about the quality of teaching in the science and the commitment of science faculty to teaching. Daempfle (2003-2004) summarized their findings: “nine out of ten switchers and three our of four persisters described the quality of science teaching as poor overall. Concerns about the pedagogical effectiveness, assessment factors and curricular structure appeared in all issues raised. The results showed that students strongly believed that faculty did not like to teach, did not value teaching as a professional activity, and valued their research above teaching” (p. 39). Terms to describe faculty during the study included “unapproachable,” “cold,” unavailable,” “aloof,” “indifferent,” and “intimidating” (Seymour & Hewitt, 1997). Further, students were dissatisfied with the one-way lecture style classes in the sciences that did not allow for any open discussion of the topics (Seymour & Hewitt, 1997).

Strenta and colleagues (1994) also conducted a study of student retention in the sciences. Utilizing a sample size larger than Seymour and Hewitt, their findings offered support for the Chilly Climate hypothesis. The results of this study revealed that science majors have much more negative feelings about their institution(s) than non-science majors. This is, again, due to a negative perception of faculty. Students in the sciences cited “instructor sarcasm” and an “unwelcoming environment” as the primary cause of this negative environment. In addition, introductory science courses (especially in biology and engineering) were considered to be dull
and uninteresting (Strenta, Et al., 1994). This was despite the fact that the students in this study claimed to be quite interested in the sciences. There was also an impression that the advanced science courses would be much more interesting than the basic courses (Strenta, Et al., 1994). This factor may also contribute to high rates of attrition during the first year and lower attrition in later years.

The results of these two studies refuted some of the traditional beliefs about student attrition in the sciences. It was previously believed that attrition was the result of large classroom sizes, language problems with foreign teaching assistants, large class sizes, and poor preparation in high school (Daempfle, 2003-2004). However, the work of Seymour and Hewitt, and Strenta Et al., provides strong evidence that this is not the case. Instead, “an intimidating classroom climate, the poor quality of undergraduate science instruction (particularly dull lecturing and poor academic advising), and a general lack of nurture for the student was cited most frequently” (Daempfle, 2003-2004, p. 41). In support of this, some studies have suggested that retention may be improved by reducing classroom competition, and incorporating interactive, cooperative learning exercises to classroom instruction (Gainen, 1995).

That does not mean that traditionally held factors have no effect. Such is the case with high school preparation courses. In fact, an inconsistency has been found between the expectations of college faculty and what high school science courses prepare students to expect (Daempfle, 2003-2004). Daempfle found that “secondary and post-secondary faculty have differing assumptions about the importance of certain student characteristics for success in college biology but that communication improved agreement on those assumptions between the two groups. Post-secondary faculty emphasized the importance of mathematics, writing skills, and integrating biology with the other subject areas while secondary faculty valued content areas
such as vocabulary knowledge and nomenclature skills (e.g., Latin usage) and dispositions such as self-discipline” (Daempfle, 2003-2004, p. 43). Additional evidence is provided by a study of chemistry teachers and professors by Razali and Yager (1994). Their study asked both groups to rate the relative importance of three basic trait categories in terms of preparation for college. These categories were knowledge, skill, and interpersonal traits (study habits, creativity, etc.). High school teachers rated chemistry knowledge and skills higher than personal traits whereas college instructors rated personal traits as highest (Razali & Yager, 1994). College faculty prefer that students enter their classes with the ability to integrate knowledge and skills into a larger context. They are less concerned with the scope of knowledge and skills brought to the classroom. This is the opposite of what most high school teachers believe (Razali & Yager, 1994) therefore students are entering their first-year science courses with a skill set that is inadequate for the course pedagogy.

Another long-standing belief about attrition in the sciences was that the students who left the sciences were unable to handle the difficulty and rigor of science courses (Daempfle, 2003-2004). This would suggest that students who switch from science majors are poorer students than those who persist. However, this has not been found to be the case. Humphreys and Friedland (1992) found that “students who persisted and students who switched earned comparable grade point averages (3.10 compared to 3.07)” (p. 5). Further, a study of 141 students, including both persisters and switchers, found that cognitive ability and course rigor were not as strongly correlated to student attrition as classroom instruction style and quality (Loftin, 1993).

Recent studies have shed light on intervention strategies that may be effective in increasing STEM persistence. Intervention strategies that focus on both learning and professional identification are effective in increasing persistence (Summers & Hrabowski, 2006).
Both learning and professional identification increase student confidence and effect motivation (Graham et al., 2013). Students in such programs identify more strongly as scientists. Identification is linked to value judgments (Eccles, 2005), therefore increasing self identification as a biologist is likely key to increasing persistence by targeting student valuation of the major. Specific strategies identified in the research include; early research experience, active learning in introductory courses, and membership in STEM learning communities (Graham et al., 2013).
CHAPTER THREE: METHODOLOGY

In the previous chapters, the theoretical and historical foundations of this study were established. The problem of student attrition was discussed and its importance stated. The theoretical framework of the Expectancy-Value Theory was introduced and the research questions were stated. The previous research into retention in the sciences and retention in general was discussed. In this chapter, the research design and methodology will be described.

Research Questions

This research project focuses on factors affecting persistence among biology majors. For the purpose of this study, the term “biology major” will include traditional biology majors and three joint majors, shared between the biology department and others. These include biochemistry (shared between Biology and Chemistry), behavioral neuroscience (shared between Biology and Psychology), and Marine Biology shared between Biology and Marine and Environmental Sciences).

This research study investigates the following research questions.

Question 1: Is persistence within the Biology major correlated to student task-value beliefs and academic self-concept as defined by expectancy-value theory?

Hypothesis 1: There is a correlation between expectancy-value measures and persistence among biology majors.
Question 2: Is there a difference in persistence rates among biology students who express premed intentions and those who do not intend to apply to medical school?

Hypothesis 2: There is a significant difference in persistence rates between premed and non-premed biology majors.

Question 3: Do students who express intentions to apply to medical school within the biology major exhibit higher task-value scores in the Student Attitude Questionnaire (SAQ) than students within the biology major who do not express premedical intentions?

Hypothesis 3: Pre-med students will exhibit lower scores on the SAQ than non-premed students.

Question 4: What are the key triggers for persistence in Biology? This open-ended question will provide context to compliment the quantitative data.

**Research Design and Rationale**

This comparative study utilized the SAQ, three additional semi-structured questions, and student enrollment data. Comparative studies examine how two or more study groups on an independent variable influence a dependent variable (Creswell, 2012). In this study, factors such as premed status and student attitudes were independent variables. Persistence and student attitudes served as dependent variables. Ultimately, this research project is investigating the factors influencing retention among Biology students. It was conducted within the Biology Department at Northeastern University. Existing enrollment data was be analyzed to determine if students who declare their intention to apply to medical school on their college application are
more likely to persist within the biology major than those who do not. To determine if premed students exhibit higher self-efficacy and value measures than non-premed students, a sample of senior students who started their university careers as biology students (including both switchers and persisters) has been identified and asked to participate in a survey to measure key variables relating to expectancy belief, and value. Finally, all the data was analyzed to see if there is a relationship between expectancy-value measurements and premed status and if this, in turn, influences persistence.

The theoretical framework of this study is Expectancy-Value Theory. Because there have been few studies of student persistence in science, there has been a theoretical framework developed that relates specifically to science persistence (Lang, 2008). Previous studies (Astin & Astin 1993, Seymour & Hewitt, 1997, Lang 2008) have utilized theoretical frameworks that focus on the phenomenon of general institutional departure, such as the Student-Centered Theory of Persistence (Stage & Hossler, 2000), and Tinto’s (1975) Student Integration Model. The one theoretical framework that has often been used in studies of persistence in STEM fields is Expectancy-Value theory, as this framework has been found to be highly accurate in predicting persistence in STEM (Besterfield-Sacre Et al., 1997; Marra Et al., 2009; Anderson & Ward, 2014; Perez Et al., 2014; Shedlosky-Shoemaker & Fautch, 2015) Therefore Expectancy-Value theory fits the currently proposed research well as a theoretical framework. The design of this study has been adapted from the designs of previous studies that have utilized this theoretical framework to investigate factors influencing student success and academic choice. Eccles and Wigfield (1995) applied this theoretical framework to investigate the relationship between student’s achievement-related beliefs and self-perception. Their work identified three variables that must be taken into account when applying the Expectancy-Value theory. These are; task
value perceptions, ability perceptions, and task difficulty perceptions. Meece and colleagues (1990) applied Expectancy-Value theory to study the relationship between math anxiety and subsequent performance and course enrollment decisions among adolescents. They utilized the Student Attitude questionnaire (SAQ) to measure student attitudes, anxiety levels, and achievement. Specifically, this questionnaire is designed to measure ability belief variables, expectancy variables, and value variables (Eccles, 1983). Multiple studies have utilized the SAQ to measure student attitudes most likely to influence persistence choices (Eccles, 1983; Meece, 1990; Wigfield & Cambria, 2010; TIMMS, 2011; Guo, Et al., 2015). Results for each of these studies have supported the use of the SAQ as an appropriate and reliable measure of student persistence behaviors. A slightly modified version of the SAQ will be utilized in the present study to measure the appropriate social cognitive variables. Specifically, these variables, as identified in the literature (Eccles, 1983; Eccles & Wigfield, 1995; Meece Et al., 1990) will include; task value perceptions, ability beliefs, task difficulty perceptions, and performance expectations. These measures, when combined with the enrollment data will, hopefully, be adequate to prove or disprove the four hypotheses.

**Study Site & Target Population**

This research was conducted within the Biology Department at Northeastern University and its target population was students who entered the university as Biology majors within the past five years. Northeastern University is a large urban university located in Boston, Massachusetts. It is currently ranked among the top 50 colleges/universities in the US and places a strong emphasis on the STEM fields. This site was chosen for its ease of access to the researcher, a current administrator within the department. The target population of this study
included both pre-med and non-premed students who entered their freshman year as biology majors. The total population size for this study was 161 students. The demographic range of the sample populations ranged from 18 to 24 year-olds of mixed ethnicities and economic backgrounds. The population was roughly, 55% female. This study focused on Biology majors as the biological sciences represent an important area on which to focus this research, as it is a broad subject with strong ties to other disciplines such as chemistry and engineering. In addition, there has not been a comprehensive study on attrition rates of all students in the biological sciences. Biology departments tend to be large and service a large number of students with a broad range of interests (genetics, biochemistry, ecology, zoology, etc). Research into what role with plays in attrition rates is lacking.

**Sampling Strategies**

Data was collected from existing enrollment data and subsequent questionnaires. Survey data was analyzed to determine if students who declare their intention to apply to medical school upon entering college are more likely to persist within the biology major than those who do not. Participants were involved in this study in two ways. Persisters were sampled during their biology Capstone course. This course is required for all senior Biology majors. The investigator visited each Capstone course during the Spring Semester of 2015 and administered the SAQ. Switchers were identified by examining the rosters of required freshman biology courses between the Fall semesters of 2009 and 2013. Academic records of each student listed as a biology/biochemistry/behavioral neuroscience major on these course rosters were checked to determine senior status and current major. Any student from this group that was no longer a
biology major was contacted via email and asked to participate in the SAQ via SurveyMonkey.com.

There are some potential weaknesses in this sampling strategy. The first is the possibility of a small sample size. As has been seen in previous studies (Lang, 2008), it is possible that not enough students who switch out of the Biology major will respond to the email request to complete the survey. If this appears to be the case, the sample may have to be increased to include institutions that have a similar student profile as Northeastern, such as Boston University and the University of Massachusetts, Boston. Another potential weakness is that the sample may be too limited. By only studying students at one institution, the data may no be representative of the larger population. If this is detected, the sample would again need to be expanded to other institutions.

**Instruments**

This research is a comparative quantitative study that utilizes student ratio enrollment data and ordinal survey data. Ratio data is interval data with a clear definition of zero to infinity (Mujis, 2010). Enrollment data fits this category, as it is the result of a count. Ordinal data is data in which the order matters but not the difference between the values (Mujis, 2010). Surveys such as the SAQ that utilize Likert-scales are generate ordinal data because each response has the same value. It is the order of the response that generates the data. Existing enrollment data has been analyzed to determine if students who declare their intention to apply to medical school on their college application are more likely to persist within the biology major than those who do not. To determine if premed students exhibit higher self-efficacy and value measures than non-premed students, a sample of senior students who started their university careers as biology
students (including both switchers and persisters) has been identified and asked to participate in a survey to measure key variables relating to expectancy belief, and value. Finally, all the data has been analyzed to see if there is a correlation between expectancy-value measurements and premed status and if this, in turn, correlates to persistence.

The design of this study was adapted from the designs of previous studies that have utilized Expectancy-Value theory as a theoretical framework to investigate factors influencing student success and academic choice. Eccles and Wigfield (1995) applied this theoretical framework to investigate the relationship between student’s achievement-related beliefs and self-perception. Their work identified three variables that must be taken into account when applying the Expectancy-Value theory. These are; task value perceptions, ability perceptions, and task difficulty perceptions. Meece and colleagues (1990) applied Expectancy-Value theory to study the relationship between math anxiety and subsequent performance and course enrollment decisions among adolescents. They utilized the Student Attitude questionnaire (SAQ) to measure student attitudes, anxiety levels, and achievement. Specifically, this questionnaire is designed to measure ability belief variables, expectancy variables, and value variables (Eccles, 1983). A slightly modified version of the SAQ will be utilized in the present study to measure the appropriate social cognitive variables (Appendix A). Specifically, these variables, as identified in the literature (Eccles, 1983; Eccles & Wigfield, 1995; Meece Et al., 1990) will include, ability beliefs, and performance expectations. In addition, the survey includes questions designed to measure the socioeconomic status of respondents. SES has been shown to have a strong impact on educational aspirations, self-concept, and achievement (TIMSS, 2011; Guo, Et al, 2015). Students were asked to answer questions about educational and study resources
available at home and parents education level. Data was also collected about gender, race, and nationality. Examples of questions from the survey include:

What was the highest degree earned by your mother? (Circle one)
High School  College (undergraduate)  Masters  Doctorate  None

Did you have your own room while growing up? Yes / No

When you first entered college did you plan to attend medical school after graduation? Yes / No

Learning biology will help me in my daily life.
Strongly Disagree  Disagree  Neither agree or disagree  Agree
Strongly agree

I need to do well in biology to get into the graduate school or professional school of my choice.
Strongly Disagree  Disagree  Neither agree or disagree  Agree
Strongly agree

I have a better understanding of biology than my classmates.
Strongly Disagree  Disagree  Neither agree or disagree  Agree
Strongly agree
This instrument has high validity and reliability for use in this study. Eccles et al. (1983) proved the validity of the SAQ by determining that expectancies and values directly influence achievement choices, performance, effort, and persistence. Both expectancies and values are influenced by beliefs that are task-specific such as “ability beliefs, the perceived difficulty of different tasks, and individual’s goals, self-schema, and affective memories” (Wigfield & Eccles, 2000, p. 69). Therefore, students who exhibit strong belief in their ability to succeed in an academic task will exhibit a higher rate of academic success than students who do not have such beliefs. These beliefs are tied to expectations of success, which have also shown to positively correlate to academic success (Meece, et al., 1990). Further, studies of student self-efficacy have shown that measures of ability beliefs are a reliable indicator of behavior (Bandura, 1997). Within this theoretical framework, beliefs and expectations both influence student success and behavior and must be distinguished from each other so that they may be treated as separate variables. Wigfield and Eccles (2000) conceptually distinguish beliefs from expectancies for success “with ability beliefs focused on present ability and expectancies focused on the future. The final variable within the Expectancy-Value theory is value. Students are expected to expend more effort on an academic task, and exhibit higher persistence within a subject if they value that task/subject highly (Eccles & Wigfield, 1995).

**Procedures**

This study was conducted during the Spring and Fall 2015 semesters at Northeastern University. Persisters were sampled during their biology Capstone course. This course is required for all senior Biology majors. The investigator visited each Capstone course during the Spring of 2015 and administered the SAQ. Switchers were identified by examining the rosters of
required freshman biology courses between the falls of 2009 and 2013. Academic records of each student listed as a biology/biochemistry/behavioral neuroscience major on these course rosters were checked to determine senior status and current major. Any student from this group that was no longer a biology major was contacted via email and asked to participate in the SAQ via SurveyMonkey.com. Survey results were scored and entered into SPSS for quantitative analysis.

**Ethical Considerations**

Using human subjects, the researcher consulted with the Office of Human Subject Research Protection at NU, submitted a proposal to the IRB, took the required training, and followed the established consent process. The application was approved by IRB before any data was collected.

Participation in the interview and questionnaire portion of the study was voluntary and students were able to opt out at any time. I tracked retention data using university records and students within these records have been kept anonymous. Further, since the researcher is an administrator/lecturer/advisor in the Biology Department in the target university, it was inevitable that there will be a preexisting relationship between the researcher and the student subjects. Because of this, it is possible that a student who was uncomfortable with the questionnaire may have felt compelled to fill it out due to a preexisting relationship with the researcher. The names of the participants were not linked to the surveys so that the researcher’s previous knowledge and opinions of the students did not affect the analysis of responses. Confidentiality in survey-based research is not only considered ethically necessary, but has been
shown to be critical in order to receive honest responses from respondents and unbiased analysis from researchers (Creswell, 2012).

**Data Analysis**

Persistence rate of both premed and non-premed biology undergraduates has been determined and descriptive statistics calculated. A T-test was performed on these continuous variables in order to determine if there is a significant difference between the two groups. Responses from the Student Attitude Questionnaire (SAQ) was analyzed via factor analysis. Previous studies that utilized the SAQ to study the effect of student self-efficacy (Eccles & Wigfield, 1995; Meece, Et al., 1990) conducted factor analysis to determine which dependent variables might be grouped together according to their effect on variance. This was followed by an ANOVA test of dependent variables in order to determine which specific variables show a significant difference between groups. Regression analysis was utilized to determine the relationship between multiple independent variables present in the SAQ and the dependent variable of persistence. To determine if premed intentions drive student attitudes, an ANOVA was performed using premed intentions upon finishing college were used as the independent variable and the SAQ measures as the dependent variables. The instruments utilized to investigate the fourth research question were the semi-structured questions, SAQ measures of socioeconomic status (SES), gender, and immigration status. The responses to the semi-structured questions were coded in order to be included in the quantitative analysis. SES data were analyzed via crosstabulation analysis. All statistical tests were derived using SPSS.
Trustworthiness Plan: Validity, Reliability and Generalizability

This study follows established methods of previously published studies of student self-efficacy and academic success (Eccles, 1983; Eccles & Wigfield, 1995; Meece et al., 1990, Guo et al., 2015), and may therefore be considered valid in this case. The validity of the current study design is verified through analysis of the relationship between the dependent variables identified by the SAQ and independent variable of premed persistence. If premed students do not show higher self-efficacy than non-premeds, then this study design may not have been valid in measuring factors that influence persistence.

Previous studies (Eccles, 1983; Meece et al., 1990; Eccles & Wigfield, 1995; Guo et al., 2015) have established the reliability of the data generated by SAQ as a predictor of student academic success. The current study is founded on reliability of this data. The analysis of the SAQ data will differ from previous studies, which relied heavily on regression analysis and factor analysis. In this study, these tools will be used, however they will be used in concert with tests designed to apply the SAQ data in the analysis of persistence data. It is unknown as of yet if this is a reliable approach.

The generalizability of the research design may be limited. This study will be conducted at a large, private research university. It is possible that the characteristics of the students in this environment may not be comparable to those of students in other types of institutions. Because of this general conclusions may not be possible from the data.

The biggest threat to this research is the possibility that no significant difference exists in retention rates between premed biology students and non-premed students. If this is revealed to be the case, research questions 2-4 will be rendered moot. However, the data from the SAQ may still be useful in an analysis of factors influencing persistence of biology majors in general.
CHAPTER FOUR: RESULTS

In the previous chapters, the justifications for this research study and its design were discussed. The problem was stated and placed in its historical context. The use of Expectancy-Value theory and the Student Attitude Questionnaire was discussed and justified. The Study group was defined and potential limitations identified. In this chapter the results of the study will be presented.

Responses were collected from 161 senior undergraduates. Of these, 114 were senior biology majors sampled during their Biology Capstone course. Of the 187 switchers identified and contacted through email, 47 (25%) responded to the survey via surveymonkey.com. Results are reported according to the research question they address. The research questions that guided this study are as follows. Is persistence within the Biology major correlated to student task-value beliefs and academic self-concept as defined by expectancy-value theory? Is there a difference in persistence rates among Biology students who express premed intentions and those who do not intend to apply to medical school? Do students who express intentions to apply to medical school within the biology major exhibit higher task-value scores in the Student Attitude Questionnaire (SAQ) than students within the biology major who do not express premedical intentions? What are the key triggers for persistence in students who express premed intentions and those that do not express such intentions?

Results for Research Question 1

Research Question 1: Is persistence within the Biology major correlated to student task-value beliefs and academic self-concept as defined by expectancy-value theory?
The hypothesis that this question will test is that there is a correlation between expectancy-value measures and persistence among biology majors.

The responses to the SAQ by both persisters and switchers are summarized in Tables 1 and 2. The results are divided into value measures and expectancy measures. The results of the regression analysis of persistence vs. SAQ responses are summarized in Table 3. Among value measures, a significant difference was found between persisters and switchers among the responses for only one question, “I need to do well in biology to get into the professional school of my choice” (Beta = 0.444, Sig. = 0.001). There were no significant differences found in expectancy measures between persisters and switchers. This suggests that, among this population, the strongest indicator of persistence is whether or not students value biology as a means of furthering their educational goals. Both persisters and switchers scored similarly in expectancy, suggesting that student self concept is not a factor in persistence among this population.

**Results for Research Question 2**

**Research Question 2:** Is there a difference in persistence rates among Biology students who express premed intentions and those who do not intend to apply to medical school?

The hypothesis for this question is that there is a significant difference in persistence rates between premed and non-premed biology majors.

Students who enter as premeds persist within biology at the same rate as non-premeds. The results of the t test for significant differences of mean persistence between premed
and non-premed students when entering college is summarized in Table 5. There appears to be a significant difference in premed intentions betweenpersisters and switchers in their senior year. Results of the t test for significant differences of mean persistence between premed and non-premed students in their senior year is summarized in Table 6. This suggests that students who have changed their mind about med-school may be less likely to stay in the biology major. This supports the previous finding that students are more likely to persist if they value biology for furthering their education.

**Results for Research Question 3**

**Research Question 3:** Do students who express intentions to apply to medical school within the biology major exhibit higher task-value scores in the Student Attitude Questionnaire (SAQ) than students within the biology major who do not express premedical intentions? This question will test the hypothesis that pre-med students will exhibit lower scores on the SAQ than non-premed students.

The responses to the SAQ by both premed students and non-premed students are summarized in Tables 7 and 8. The results are again divided into value measures and expectancy measures. To determine if premed intentions drive student attitudes, an ANOVA was performed using premed intentions upon finishing college were used as the independent variable and the SAQ measures as the dependent variables. This is the reverse of what was done for question one. The results, summarized in Table 9, show significant relationships between persistence and following questions: I enjoy learning biology (Sig. = 0.003), learning biology will help me in my daily life (Sig. = 0.004), biology is important to get into the professional school of my choice (Sig. = 0.000), biology is important to get the job I want (Sig. = 0.000), and I usually do well in
biology courses (Sig. = 0.006). The latter was the only difference found in expectancy values during this study. Next, the test was repeated using “entering college as a premed” as the independent variable (Table 10). No significant relationships were detected from this test.

Results for Research Question 4

Research Question 4: What are the key triggers for persistence in biology?

All respondents were asked why they chose biology as a major upon entering college. The full text of these responses is included in Appendix A. Responses were analyzed via crosstabulation and are summarized in Table 11. There was no significant relationship between the reason for choosing biology (e.g. high school experience, family pressure) and persistence. The similarity of responses among persisters and switchers is illustrated by some the responses. These responses include:

**Persister:** I had a really amazing AP bio teacher in high school who showed me that I could do well in science if I put my mind to it and I love the ocean.

**Switcher:** I've always been interested in the medical field, and biology and chemistry were my favorite subjects in high school.

**Persister:** always liked the subject

**Switcher:** I love Biology and it sounded cool

**Persister:** I am interested in medicine and health and the core of these interests lie in biology
Switcher: To get into medicine and healthcare.

Persister: Med school requirements

Switcher: I was interested in med school and had a passion for biology from high school.

Persister: I chose to become a bio major because I was always good in science in hs and I really enjoyed learning about the study of life

Switcher: I excelled at high school biology and really enjoyed learning about the topic.

Switchers were asked why they decided to leave the biology major in an open response question format. Full responses are included in Appendix C. Responses fell into four major categories. The first category was “changing mind about premed.” Sample responses include:

“I am no longer interested in medical school and am now looking at rehabilitation and recreational therapy.”

“I decided to leave the biology major because I decided I no longer wanted to become a doctor.”

“I realized I didn't want to be a doctor and that I didn't want to do lab work.”

The second category was a lack of interest in biology. Sample responses include:

“I am not very interest about studying animals. Also I wanted to take more non-science classes specially in the public health area. Also, the coops offered in this department did not seem interesting for me(too much lab, I wanted more patient interaction.”
“Many reasons. I don't know what I would do with a Bio Degree, I wasn't doing well, and I was bored with the classes (Not that business is more interesting)”

The third category was “career fit.” Sample responses include:

“I decided that a Psych major with a BNS minor would be better for pursuing clinical care or research involving human participants, which was where my focus was shifting. I would also be lying if I said my aversion to taking organic chemistry wasn't a fact”

“I decided that the post-graduation path for the sciences was too narrow, and I realized that I wanted to go into more general health sciences revolving around health advocacy and possibly health policy.”

“The biology curriculum seemed set up for students looking to take the MCAT and go to medical school. I am more interested in research and was also interested in geology”

“While I enjoyed learning about biology, I felt constricted in my future career choices, and since I didn't want to be a doctor or work in a lab my whole life, I switched out of that path. I also found my love for art during that stressful time of deciding.”

“After taking chemistry and calculus, I realized I didn't want to continue for 4-8 years. Biology was still interesting, I just realized I didn't want it as a career.”

“I was unaware of all of the possible careers associated with a Biology major.”

The fourth category was “academic difficulty.” Sample responses include:

“I did very poorly in the general level intro biology class. I tried very hard but something wasn't clicking. I also switched because I thought the Linguistics/Psychology major was a smarter decision for what my career goals were at the time.”

“it was too difficult/demanding and the passion wasn’t there.”

“I couldn't handle the Chemistry requirements.”
“I struggled with the material enough where I knew I would not make it to medical school and decided to change my career path. I could not see myself in a research position and that is what I would have ended up doing with my biology degree.”

“Intro to Chemistry showed me I would never do well in it.”

The frequencies of responses are reported in Table 12. Chi Square analysis revealed no significant difference between reasons for leaving the biology major ($\chi^2 = 4.01, P = 0.075$).

Results thus far indicate that job and professional school aspirations are among the key triggers of persistence among NU biology majors. Those who feel the biology is important for their goals will persist. The lack of significant difference in expectancy values may be due to socioeconomic homogeneity among the population. The descriptive statistics for responses to the SAQ for SES measures are summarized in Table 13. Questions varied from “yes/no” responses to a five-point scale. The complete text of the questions can be found in the full questionnaire (Appendix). The majority of students are from high SES households regardless of gender, race or nationality. Research supports a strong correlation between SES and academic achievement in the STEM fields (TIMMS, 2011). The parents of the majority of students had attained at least a college degree (mean = 3, with 3 = college degree). Research has found that parents with higher educational achievement will have higher education aspirations for their children and that this is a powerful predictor of educational success in the sciences (Hong & ho, 2005; TIMMS, 2011). In this study, persistence was not related to parental education (Table 14). However, a significant relationship was found between persistence and having an older sibling who attended college among those students who had an older sibling (Table 15). Most students (mean = 3.4) had at least 100 books in their home (a measure of educational resources available at home). Most had their own room (mean = 1.8 on yes/no scale with 2 = yes), and 100% had
internet access at home (a measure of study resources). In addition, 100% of the students sampled had their own computer and a computer at home (means of 1.99 for both questions on yes/no scale with 2 = yes). The sample in this study is greatly skewed towards students that would fall into the “many resources” category. This suggests that SES is an overriding factor for differences found in other studies. This includes gender and recent immigration to the USA. Table 17 summarizes the regression analysis of persistence vs. recency of immigration. There was no significant relationship between these two variables. This also holds true for gender. Table 18 summarizes the crosstabulation of persistence and gender. Again, no significant relationship was found. Finally, the relationship between race/nationality and persistence was examined. Students self identified their race or nationality. Responses were coded as White/Caucasian (1), Black/African (2), Hispanic (3), Middle Eastern (4), Asian/Pacific Islander (5), Native American (6), Indian (7), Mixed (8). Crosstabulation analysis of results are summarized in Table 19. No significant relationship was found between persistence and race/nationality in this population.
Table 4.1: Frequency Table of SAQ Responses (Value Measures)

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>I enjoy learning biology (Persisters)</td>
<td>0.0</td>
<td>1.8</td>
<td>5.3</td>
<td>28.9</td>
<td>64.0</td>
</tr>
<tr>
<td>I enjoy learning biology (Switchers)</td>
<td>4.2</td>
<td>0</td>
<td>12.5</td>
<td>54.2</td>
<td>29.2</td>
</tr>
<tr>
<td>Biology is Boring (Persisters)</td>
<td>47.4</td>
<td>39.5</td>
<td>8.8</td>
<td>4.4</td>
<td>0</td>
</tr>
<tr>
<td>Biology is Boring (Switchers)</td>
<td>27.1</td>
<td>50.0</td>
<td>14.6</td>
<td>6.3</td>
<td>2.1</td>
</tr>
<tr>
<td>I like learning Biology (Persisters)</td>
<td>0</td>
<td>0.9</td>
<td>2.6</td>
<td>35.1</td>
<td>61.4</td>
</tr>
<tr>
<td>I like learning Biology (Switchers)</td>
<td>2.1</td>
<td>0</td>
<td>6.3</td>
<td>56.3</td>
<td>35.4</td>
</tr>
<tr>
<td>Learning biology will help me in my daily life (Persisters)</td>
<td>0</td>
<td>2.6</td>
<td>13.2</td>
<td>45.6</td>
<td>38.6</td>
</tr>
<tr>
<td>Learning biology will help me in my daily life (Switchers)</td>
<td>4.2</td>
<td>14.6</td>
<td>27.1</td>
<td>43.8</td>
<td>10.4</td>
</tr>
<tr>
<td>Learning biology will help learn other subjects (Persisters)</td>
<td>2.6</td>
<td>18.4</td>
<td>31.6</td>
<td>36.8</td>
<td>10.5</td>
</tr>
<tr>
<td>Learning biology will help learn other subjects (Switchers)</td>
<td>8.3</td>
<td>0.4</td>
<td>25.0</td>
<td>37.5</td>
<td>18.8</td>
</tr>
<tr>
<td>I need to learn biology to get into the professional school of my choice (Persisters)</td>
<td>0.9</td>
<td>4.4</td>
<td>3.5</td>
<td>30.7</td>
<td>60.5</td>
</tr>
<tr>
<td>I need to learn biology to get into the professional school of my choice (Switchers)</td>
<td>16.7</td>
<td>31.3</td>
<td>18.8</td>
<td>16.7</td>
<td>16.7</td>
</tr>
<tr>
<td>I need to learn biology to get the job of my choice (Persisters)</td>
<td>0</td>
<td>7.0</td>
<td>7.9</td>
<td>33.3</td>
<td>51.8</td>
</tr>
<tr>
<td>I need to learn biology to get the job of my choice (Switchers)</td>
<td>20.8</td>
<td>29.2</td>
<td>10.4</td>
<td>29.2</td>
<td>10.4</td>
</tr>
</tbody>
</table>

1=Strongly Disagree, 2=Disagree, 3=Neither Agree Nor Disagree, 4=Agree, 5=Strongly Agree
Table 4.2: Frequency Table of SAQ Responses (Expectancy Measures)

<table>
<thead>
<tr>
<th>Response</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>I usually do well in biology courses (Persisters)</td>
<td>0</td>
<td>5.3</td>
<td>3.5</td>
<td>48.2</td>
<td>43.0</td>
</tr>
<tr>
<td>I usually do well in biology courses (Switchers)</td>
<td>2.1</td>
<td>14.6</td>
<td>16.7</td>
<td>50.0</td>
<td>16.7</td>
</tr>
<tr>
<td>I usually do well in lab courses (Persisters)</td>
<td>0</td>
<td>4.4</td>
<td>4.4</td>
<td>52.6</td>
<td>38.6</td>
</tr>
<tr>
<td>I usually do well in lab courses (Switchers)</td>
<td>6.3</td>
<td>6.3</td>
<td>29.2</td>
<td>39.6</td>
<td>18.8</td>
</tr>
<tr>
<td>I have good lab skills (Persisters)</td>
<td>0.9</td>
<td>2.6</td>
<td>7.0</td>
<td>51.8</td>
<td>37.7</td>
</tr>
<tr>
<td>I have good lab skills (Switchers)</td>
<td>6.3</td>
<td>2.6</td>
<td>18.8</td>
<td>54.2</td>
<td>18.8</td>
</tr>
<tr>
<td>Biology is harder for me than for my classmates (Persisters)</td>
<td>16.7</td>
<td>42.1</td>
<td>29.8</td>
<td>7.0</td>
<td>4.4</td>
</tr>
<tr>
<td>Biology is harder for me than for my classmates (Switchers)</td>
<td>4.2</td>
<td>37.5</td>
<td>20.8</td>
<td>29.2</td>
<td>8.3</td>
</tr>
<tr>
<td>I’m just not that good at biology (Persisters)</td>
<td>36.8</td>
<td>54.4</td>
<td>6.1</td>
<td>2.6</td>
<td>0</td>
</tr>
<tr>
<td>I’m just not that good at biology (Switchers)</td>
<td>22.9</td>
<td>47.9</td>
<td>14.6</td>
<td>10.4</td>
<td>4.2</td>
</tr>
<tr>
<td>I learn things quickly in biology (Persisters)</td>
<td>0</td>
<td>9.6</td>
<td>20.2</td>
<td>54.4</td>
<td>15.8</td>
</tr>
<tr>
<td>I learn things quickly in biology (Switchers)</td>
<td>4.2</td>
<td>27.1</td>
<td>18.8</td>
<td>41.7</td>
<td>8.3</td>
</tr>
<tr>
<td>I have a better understanding of biology than my classmates (Persisters)</td>
<td>0.9</td>
<td>14.0</td>
<td>49.1</td>
<td>28.9</td>
<td>7.0</td>
</tr>
<tr>
<td>I have a better understanding of biology than my classmates (Switchers)</td>
<td>6.3</td>
<td>29.2</td>
<td>37.5</td>
<td>20.8</td>
<td>36.3</td>
</tr>
</tbody>
</table>

1=Strongly Disagree, 2=Disagree, 3=Neither Agree Nor Disagree, 4=Agree, 5=Strongly Agree
Table 4.3: Regression Analysis of Persistence vs. SAQ Responses

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>Degrees of Freedom</th>
<th>Mean Square</th>
<th>F</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>15.568</td>
<td>15</td>
<td>1.038</td>
<td>8.212</td>
<td>.000&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Residual</td>
<td>17.567</td>
<td>139</td>
<td>.126</td>
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<td></td>
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<tr>
<td>Total</td>
<td>33.135</td>
<td>154</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

**REGRESSION**

<table>
<thead>
<tr>
<th>Unstandardized Coefficient</th>
<th>Standardized Coefficients</th>
<th>95.0% Confidence Interval for B</th>
</tr>
</thead>
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<tr>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
</tr>
<tr>
<td>(Constant)</td>
<td>.498</td>
<td>.512</td>
</tr>
<tr>
<td>enjoy</td>
<td>-.027</td>
<td>.063</td>
</tr>
<tr>
<td>boring</td>
<td>.064</td>
<td>.051</td>
</tr>
<tr>
<td>like</td>
<td>-.023</td>
<td>.074</td>
</tr>
<tr>
<td>daily</td>
<td>.091</td>
<td>.041</td>
</tr>
<tr>
<td>subjects</td>
<td>-.051</td>
<td>.029</td>
</tr>
<tr>
<td>professionalschool</td>
<td>.165</td>
<td>.048</td>
</tr>
<tr>
<td>job</td>
<td>.038</td>
<td>.049</td>
</tr>
<tr>
<td>dowellcourses</td>
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<td>.059</td>
</tr>
<tr>
<td>dowelllabs</td>
<td>.059</td>
<td>.042</td>
</tr>
<tr>
<td>labskills</td>
<td>.008</td>
<td>.042</td>
</tr>
<tr>
<td>harder</td>
<td>-.056</td>
<td>.042</td>
</tr>
<tr>
<td>justnotgood</td>
<td>.022</td>
<td>.052</td>
</tr>
<tr>
<td>learnquickly</td>
<td>.031</td>
<td>.048</td>
</tr>
<tr>
<td>betterunderstanding</td>
<td>-.085</td>
<td>.046</td>
</tr>
<tr>
<td>whychoose</td>
<td>-.023</td>
<td>.031</td>
</tr>
</tbody>
</table>
# Table 4.4: ANOVA With Multiple Independent Variables Analysis of SAQ Responses vs. Persistence

<table>
<thead>
<tr>
<th>Source</th>
<th>Type III Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected Model</td>
<td>20.850(^a)</td>
<td>54</td>
<td>.386</td>
<td>3.196</td>
<td>.000</td>
</tr>
<tr>
<td>Intercept</td>
<td>8.843</td>
<td>1</td>
<td>8.843</td>
<td>73.197</td>
<td>.000</td>
</tr>
<tr>
<td>enjoy</td>
<td>.067</td>
<td>4</td>
<td>.017</td>
<td>.139</td>
<td>.967</td>
</tr>
<tr>
<td>boring</td>
<td>.271</td>
<td>3</td>
<td>.090</td>
<td>.748</td>
<td>.526</td>
</tr>
<tr>
<td>like</td>
<td>.118</td>
<td>3</td>
<td>.039</td>
<td>.325</td>
<td>.807</td>
</tr>
<tr>
<td>daily</td>
<td>.164</td>
<td>4</td>
<td>.041</td>
<td>.340</td>
<td>.850</td>
</tr>
<tr>
<td>subjects</td>
<td>.497</td>
<td>4</td>
<td>.124</td>
<td>1.029</td>
<td>.396</td>
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<tr>
<td>professionalschool</td>
<td>2.133</td>
<td>4</td>
<td>.533</td>
<td>4.413</td>
<td>.002</td>
</tr>
<tr>
<td>job</td>
<td>.405</td>
<td>4</td>
<td>.101</td>
<td>.837</td>
<td>.505</td>
</tr>
<tr>
<td>dowellcourses</td>
<td>.341</td>
<td>3</td>
<td>.114</td>
<td>.940</td>
<td>.424</td>
</tr>
<tr>
<td>dowelllabs</td>
<td>1.573</td>
<td>4</td>
<td>.393</td>
<td>3.255</td>
<td>.015</td>
</tr>
<tr>
<td>labskills</td>
<td>.308</td>
<td>4</td>
<td>.077</td>
<td>.638</td>
<td>.636</td>
</tr>
<tr>
<td>harder</td>
<td>.894</td>
<td>4</td>
<td>.223</td>
<td>1.850</td>
<td>.125</td>
</tr>
<tr>
<td>justnotgood</td>
<td>.241</td>
<td>4</td>
<td>.060</td>
<td>.499</td>
<td>.736</td>
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<tr>
<td>learnquickly</td>
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<td>.027</td>
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<td>betterunderstanding</td>
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<td>4</td>
<td>.130</td>
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<tr>
<td>Error</td>
<td>12.927</td>
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<tr>
<td>Total</td>
<td>504.000</td>
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<tr>
<td>Corrected Total</td>
<td>33.778</td>
<td>161</td>
<td></td>
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</tr>
</tbody>
</table>

\(a. \) R Squared = .617 (Adjusted R Squared = .424)
Table 4.5: Persistence vs. Premed Intentions Entering College

<table>
<thead>
<tr>
<th>Persist?</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>48</td>
<td>1.6250</td>
<td>.48925</td>
<td>.07062</td>
</tr>
<tr>
<td>YES</td>
<td>113</td>
<td>1.5752</td>
<td>.49651</td>
<td>.04671</td>
</tr>
</tbody>
</table>

Independent Samples Test

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>Sig.</th>
<th>T</th>
<th>Df</th>
<th>Sig. (2-tailed)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.603</td>
<td>0.207</td>
<td>0.584</td>
<td>159</td>
<td>0.560</td>
</tr>
</tbody>
</table>

Table 4.6: Persistence vs. Premed Intentions During Senior Year of College

<table>
<thead>
<tr>
<th>Premed?</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO</td>
<td>54</td>
<td>1.5556</td>
<td>.50157</td>
<td>.06826</td>
</tr>
<tr>
<td>YES</td>
<td>41</td>
<td>1.8537</td>
<td>.35784</td>
<td>.05589</td>
</tr>
</tbody>
</table>

Independent Samples Test

<table>
<thead>
<tr>
<th></th>
<th>F</th>
<th>Sig.</th>
<th>T</th>
<th>Df</th>
<th>Sig. (2-tailed)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>47.3</td>
<td>0.00</td>
<td>-3.23</td>
<td>93</td>
<td>0.002</td>
</tr>
</tbody>
</table>
Table 4.7: Frequency Table of SAQ Responses (Value Measures)

<table>
<thead>
<tr>
<th>Response</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>I enjoy learning biology (Premed)</td>
<td>0</td>
<td>0</td>
<td>3.9</td>
<td>21.6</td>
<td>74.5</td>
</tr>
<tr>
<td>I enjoy learning biology (Non-Premed)</td>
<td>1.8</td>
<td>1.8</td>
<td>9.2</td>
<td>42.2</td>
<td>45.0</td>
</tr>
<tr>
<td>Biology is Boring (Premed)</td>
<td>49.0</td>
<td>41.2</td>
<td>5.9</td>
<td>3.9</td>
<td>0</td>
</tr>
<tr>
<td>Biology is Boring (Non-Premed)</td>
<td>37.6</td>
<td>43.1</td>
<td>12.8</td>
<td>5.5</td>
<td>0.9</td>
</tr>
<tr>
<td>I like learning Biology (Premed)</td>
<td>0</td>
<td>0</td>
<td>2.0</td>
<td>29.4</td>
<td>68.6</td>
</tr>
<tr>
<td>I like learning Biology (Non-Premed)</td>
<td>0.9</td>
<td>0.9</td>
<td>4.6</td>
<td>45.9</td>
<td>47.7</td>
</tr>
<tr>
<td>Learning biology will help me in my daily life (Premed)</td>
<td>0</td>
<td>2.0</td>
<td>9.8</td>
<td>45.1</td>
<td>43.1</td>
</tr>
<tr>
<td>Learning biology will help me in my daily life (Non-Premed)</td>
<td>1.8</td>
<td>7.3</td>
<td>21.1</td>
<td>45.0</td>
<td>24.8</td>
</tr>
<tr>
<td>Learning biology will help learn other subjects (Premed)</td>
<td>3.9</td>
<td>15.7</td>
<td>35.3</td>
<td>31.4</td>
<td>13.7</td>
</tr>
<tr>
<td>Learning biology will help learn other subjects (Non-Premed)</td>
<td>4.6</td>
<td>16.5</td>
<td>25.7</td>
<td>40.4</td>
<td>12.8</td>
</tr>
<tr>
<td>I need to learn biology to get into the professional school of my choice (Premed)</td>
<td>0</td>
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1=Strongly Disagree, 2=Disagree, 3=Neither Agree Nor Disagree, 4=Agree, 5=Strongly Agree
Table 4.8: Frequency Table of SAQ Responses (Expectancy Measures)

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1=Strongly Disagree, 2=Disagree, 3=Neither Agree Nor Disagree, 4=Agree, 5=Strongly Agree
Table 4.9: ANOVA with multiple dependent variables analysis of SAQ v. finishing college as premed

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Table 4.10: ANOVA with multiple dependent variables analysis of SAQ v. entering college as premed

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### Table 4.11: Persistence vs. Reasons for Choosing Biology as a Major

**Crosstabulation**

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### Chi-Square Test

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1=Changed mind about premed, 2=Interest, 3=Career Fit, 4=Academic Difficulty

$X^2=4.01$

$P=0.075$

Table 4.13: Descriptive Statistics for Socioeconomic Measures From All Respondents

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<tr>
<td>internet</td>
<td>162</td>
<td>2.00</td>
<td>2.00</td>
<td>2.0000</td>
<td>.00000</td>
</tr>
<tr>
<td>owencomputer</td>
<td>162</td>
<td>1.00</td>
<td>2.00</td>
<td>1.9938</td>
<td>.07857</td>
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<tr>
<td>computerhome</td>
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<td>1.00</td>
<td>2.00</td>
<td>1.9877</td>
<td>.11077</td>
</tr>
<tr>
<td>Valid N (listwise)</td>
<td>151</td>
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Table 4.14: Regression Analysis for Persistence vs. Family Academic Expectations

<table>
<thead>
<tr>
<th></th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
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<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
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<tr>
<td>(Constant)</td>
<td>.884</td>
<td>.160</td>
<td>5.534</td>
<td>.000</td>
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<tr>
<td>degreemother</td>
<td>-.007</td>
<td>.037</td>
<td>-.014</td>
<td>-.192</td>
</tr>
<tr>
<td>degreefather</td>
<td>.026</td>
<td>.030</td>
<td>.064</td>
<td>.878</td>
</tr>
<tr>
<td>siblingcollege</td>
<td>.361</td>
<td>.048</td>
<td>.527</td>
<td>7.576</td>
</tr>
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</table>

a. Dependent Variable: persist

Table 4.15: Crosstabulation Analysis of persistence vs. having an older sibling who attended college (Response 3, “Not Applicable” removed).

<table>
<thead>
<tr>
<th>siblingcollege</th>
<th>NO</th>
<th>Yes</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>persist</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td>14</td>
<td>25</td>
<td>39</td>
</tr>
<tr>
<td>2.00</td>
<td>4</td>
<td>59</td>
<td>63</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>84</td>
<td>102</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chi-Square Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
Table 4.16: Regression Analysis of Persistence vs. Resources

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>t</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>2.723</td>
<td>1.158</td>
<td>2.351</td>
</tr>
<tr>
<td></td>
<td>books</td>
<td>-.005</td>
<td>.034</td>
<td>-.012</td>
</tr>
<tr>
<td></td>
<td>ownroom</td>
<td>.072</td>
<td>.097</td>
<td>.060</td>
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<td></td>
<td>owncomputer</td>
<td>-.278</td>
<td>.466</td>
<td>-.048</td>
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<td></td>
<td>computerhome</td>
<td>-.290</td>
<td>.329</td>
<td>-.071</td>
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</table>

a. Dependent Variable: persist

Table 4.17: Binary Logistic Regression Analysis of Persistence vs. Recency of Immigration

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<tr>
<th>df</th>
<th>Sig.</th>
<th>Exp(B)</th>
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<tbody>
<tr>
<td>english</td>
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<td>.451</td>
</tr>
<tr>
<td>borninUS</td>
<td>1</td>
<td>.693</td>
</tr>
<tr>
<td>parentsbornUS</td>
<td>1</td>
<td>.167</td>
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<tr>
<td>Constant</td>
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<td>.548</td>
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Table 4.18: Crosstabs Analysis of Persistence vs. Gender

### persist vs. gender Crosstabulation

<table>
<thead>
<tr>
<th></th>
<th>gender</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1.00</td>
<td>2.00</td>
<td>3.00</td>
<td>Total</td>
<td></td>
<td></td>
</tr>
<tr>
<td>persist</td>
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<td>32</td>
<td>16</td>
<td>0</td>
<td>48</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>YES</td>
<td>74</td>
<td>39</td>
<td>1</td>
<td>114</td>
<td></td>
<td></td>
</tr>
<tr>
<td>total</td>
<td></td>
<td>106</td>
<td>55</td>
<td>1</td>
<td>162</td>
<td></td>
<td></td>
</tr>
<tr>
<td>count</td>
<td></td>
<td>106.0</td>
<td>55.0</td>
<td>1.0</td>
<td>162.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>expected count</td>
<td></td>
<td>106.0</td>
<td>55.0</td>
<td>1.0</td>
<td>162.0</td>
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### Chi-Square Test

<table>
<thead>
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<th></th>
<th>Value</th>
<th>df</th>
<th>Asymptotic Sig (2-sided)</th>
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</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>.445</td>
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<td>.801</td>
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Table 4.19: Crosstabulation Analysis of Persistence vs. Race/Nationality

### persist vs. race Crosstabulation

<table>
<thead>
<tr>
<th>Persist</th>
<th>Race</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1.00</td>
<td>2.00</td>
<td>3.00</td>
<td>4.00</td>
<td>5.00</td>
<td>6.00</td>
<td>7.00</td>
<td>8.00</td>
</tr>
<tr>
<td>NO</td>
<td></td>
<td>29</td>
<td>3</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>YES</td>
<td></td>
<td>72</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>13</td>
<td>2</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>101</td>
<td>6</td>
<td>10</td>
<td>6</td>
<td>16</td>
<td>2</td>
<td>6</td>
<td>11</td>
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### Chi-Square Test

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>df</th>
<th>Asymptotic Sig (2-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>8.01</td>
<td>7</td>
<td>.331</td>
</tr>
</tbody>
</table>
CHAPTER FIVE: DISCUSSION AND CONCLUSIONS

In the previous chapters, the justifications for this research study and its design were discussed. The problem was stated and placed in its historical context. The use of Expectancy-Value theory and the Student Attitude Questionnaire was discussed and justified. The Study group was defined and potential limitations identified. The results of the study were presented in both text and tabulated format. In this chapter those results will be discussed and compared to the previous literature. Suggestions and areas of future research will also be discussed.

This discussion will be organized around the findings related to each research question. The research questions that guided this study are as follows. Is persistence within the Biology major correlated to student task-value beliefs and academic self-concept as defined by expectancy-value theory? Is there a difference in persistence rates among Biology students who express premed intentions and those who do not intend to apply to medical school? Do students who express intentions to apply to medical school within the biology major exhibit higher task-value scores in the Student Attitude Questionnaire (SAQ) than students within the biology major who do not express premedical intentions? What are the key triggers for persistence in Biology?

Research Question 1

For research question one, the results suggest persistence is related to value measures for this population. Students who perceive a biology degree as necessary for their career goals will persist at higher rate than those who do not. Previous research supports this finding. Persistence has been defined within the field of psychology as a manifestation of motivation (Bandura, 1989). Lent, Brown, and Hackett (1994, 2000) utilized this framework while forming their Social Cognitive Career Theory. This theory posits that career choices are shaped by a
combination of personality and environment, both intrinsic and extrinsic influences. Since, these influences shape career aspirations, they are intricately involved building the value that student will place on the degree that will help them achieve their career goal. Tai and colleagues (2006) found that early career expectations were a significant indicator of persistence within STEM subjects. Wigfield and Cambria (2010) posit that answering the question “Do I want to do this activity and why?” is crucial to determining motivation. Students who do not find value in an academic task are less likely complete that task regardless of their ability to do so. This is what Eccles (1995) defines as “interest value,” a composite of achievement value, goal orientation and interest. The present study suggests that interest value is a key indicator of persistence within the biology major. Another variation of value, “utility value,” is also applicable in this case. Utility value reflects how a task fits into the future goals and plans of an individual. It is strongest for activities that are deemed useful in attaining goals that are deeply held and are strongly tied to an individual’s sense of self (Eccles, 2005). In this way, it is clear that students who identify strongly as biologists or identify with career goals that may necessitate biology are more likely to persist.

Expectancy measures, the second half of the expectancy-value theory, played no significant role in persistence within the biology major in this population. This finding runs counter to the published data. There are numerous studies that have found a link between expectancy and academic persistence within STEM (Besterfield-Sacre Et al., 1997; Marra Et al., 2009; Anderson & Ward, 2014; Perez Et al., 2014; Shedlosky-Shoemaker & Fautch, 2015). These studies found that students who lacked confidence in their ability to succeed in a STEM major were less likely to persist within STEM. The work of Shedlosky-Shoemaker and Fautch (2015) stand in contrast to the current study as their application of expectancy-value theory in a
study of persistence among undergraduate chemistry majors found that expectancy was a crucial factor in persistence. They found that students who reported a higher level of self-doubt were more likely to leave the chemistry major. This self-doubt was not restricted to STEM but more general to academic ability overall. In addition, they found that value measures had no significant relationship to persistence. Further, Lang (2008) found that the most important factor influencing persistence among biology majors at the University of Austin was academic difficulty and dissatisfaction. Lang also found that value and interest played to role in persistence among biology majors in her study. She concluded that persisters did not actively decide to stay in the biology major. They just did not happen to leave, regardless of their dissatisfaction with the major. However, this may be more an indictment of the state of teaching within the biology department at the University of Austin than a reflection of national attitudes towards biology.

The discrepancy in findings between previous studies and current study may be due three factors. First, this study measured student attitudes upon completing college as opposed to upon entering college as Shedlosky-Shoemaker and Fautch did. It is possible that students in this study gained confidence as they progressed in their college career. Also, this study did not include students who had left the university after their freshman year. This may have skewed my data so that it was less likely to mirror a study of freshman attitudes. Thirdly, a difference may exist in the demographic make-up of the participants in each study. Unfortunately, Shedlosky-Shoemaker and Fautch did not report demographic data for their study population. The influence of demographics in this study will be discussed later.
Research Questions 2 and 3

Questions 2 and 3 will be discussed together as they both deal specifically with the relationship between premed intentions and retention within the biology major. Previous research focusing of premed students has found their motivations to be primarily extrinsic (Horowitz, 2009). Essentially, premed students were found to be motivated by the desire to get accepted to medical school but not any sense of intrinsic identity. This is supported by the present study. While students entering college as premeds showed no significant difference in persistence within the biology major when compared to those who entered the biology major with no plans to attend medical school, students who decided that they no longer desired to attend medical school were more likely to switch away from biology.

Both premed students and non-premed students scored similarly on the SAQ with the exception of value. Premed students were not more confident in their academic abilities than non-premed students. In general, premed students also valued biology to same degree as non-premeds leading to no significant difference in SAQ values between the two populations. However, the subset of premed students who only valued biology a means to gain acceptance to medical school were more likely to leave the biology major if they decided they no longer wanted to attend medical school. This relationship was clear in the persistence rates and in the responses to the open-ended question, “Why did you decide to leave the biology major?” This fits with the overall conclusion that value measures are the most significant indicator if persistence among biology majors at NU. In ensuring that its curriculum fulfills the requirements of medical school admissions, the biology department at NU is increasing the likelihood that students who choose biology as a path to medical school will persist within biology as long as they persist within the premed track. However, there is no evidence there is any
difference in academic performance or persistence between the overall populations of premed or non-premed students.

It is important to note that students who left the biology major after deciding they were not interested in pursuing a career in medicine expressed that their lack of knowledge of other career paths within biology. Switchers stated that they felt as though the only paths available to a biology major where medical school or research. Students who were not interested in a career in either discipline were likely to switch to another major. This included many students who had initially intended to apply to medical school, but decided against it. Reasons for deciding against attending medical school included both academic reasons and changing interests. The loss of these students represents a lost opportunity. Effort must be made to ensure the biology majors are aware of the vast array of career options available to them so that students who decide they no longer desire medical school will be aware of the other options available to them if they continue within the biology major. However, the majority of premed biology students do persist within the major due to that value they place on their major as a means of achieving their goal. Therefore, it is sound practice for biology departments to ensure their curricula adhere to medical school requirements.

**Research Question 4**

A relationship has been found in previous research between confidence and persistence in STEM (Besterfield-Sacre Et al., 1997; Lang, 2008; Marra Et al., 2009; Anderson & Ward, 2014; Perez Et al., 2014; Shedlosky-Shoemaker & Fautch, 2015). This ties persistence with the expectancy component of the expectancy-value theory as students who have low self-concept and therefore low expectancy of success, do persist at as high a rate as students who express
higher levels of confidence. Student expectancies are influenced by the perception of external sources. These influences include beliefs and behaviors of parents and teachers (socializers) and cultural climate (Wigfield & Cambria, 2010). These help to shape an individual’s perception of what is expected of them academically. In this study, most students came from families that would be considered to provide a strong educational expectation. Most students had parents who had attained at least a college degree and most came from homes where there were numerous books. This would instill a perception of high academic expectations on an individual. This has been shown to have a positive influence on persistence in STEM (TIMSS, 2011; Shedlosky-Shoemaker & Fautch, 2015). Students who come from backgrounds with academic expectancy may be more vulnerable to becoming discouraged or demoralized in the face of academic difficulty or competition from classmates (Shedlosky-Shoemaker & Fautch, 2015). Higher level of education among parents generally indicates a career in a higher paying profession, higher SES, and homes with more resources (TIMSS, 2011). For instance, as seen in this study, students from higher SES households are more likely to have access to books and the internet as study resources. Previous studies support a positive relationship between then number of books at home and academic success in the STEM field (TIMSS, 2011). They are also more likely to have their own room, which is also seen as a study resource because it provides a quite place to study undisturbed. In this study, all students had internet access. Most had access to multiple books and had their own room. It is likely that the educational level of their parents allowed access to such resources putting these students at an advantage. This is further supported in this study by the significant relationship found between persistence and having an older sibling who attended college. In this way, having witnessed a sibling attending college sets an academic expectation for an individual. It should be noted, however, that this relationship might be
influenced by the possibility of that a sibling who attended college is also an indicator of resources to achieve academic success (both academic and financial). This may skew this finding, however most participants in this study come from what would be classified as “high resource” backgrounds according to TIMSS (2011) so it is interesting that this relationship between sibling academic progress and persistence was found among a population that showed a fairly constantly high SES.

The relationship between SES and persistence in STEM has been well established. A review of the literature reveals that the positive relationship between high SES and STEM persistence as been consistently supported (TIMSS, 2011). In fact, studies have found a direct link between SES and academic achievement (Sirin, 2005). As discussed above, this is due to two major factors. The first is available resources for studying. This includes availability of study aids such as books and internet. It also includes study resources such as computers and a study area within the home. The second factor is the instilling of educational aspirations and self-confidence by parents who, themselves, have attained a higher level of education. Eccles (2007) theorizes that parents provide “socio-emotional” influences on their children’s motivations and beliefs, which shapes their educational aspirations and confidence. This is directly linked to greater academic success and persistence (Eccles, 2007). In the present study, the majority of participants were from high SES households with parents that have achieved at least a college degree. This is likely the explanation for the lack or variance in responses for the “expectancy” questions in the SAQ. All respondents scored highly for questions related to academic ability and level of understanding within biology. A lack of belief in ability to succeed did not have a significant impact on retention within this population. This suggests that the most important factor in shaping student self-concept is socioeconomic status, regardless of gender,
race, or nationality. It should be noted that a study by Guo Et al. (2015) found that SES had a greater impact on the academic success of boys versus girls. Such a relationship was not detected in this study.

The lack of significant difference in persistence between genders and races was similar to what was found by Shedlosky-Shoemaker & Fautch, (2015). However this does stand in contrast with much of the published research. For instance, previous studies have found a significant difference in persistence between males and females within the STEM field (Wang Et al., 2015). Seymour and Hewitt (1997) found the attrition rate for women and minorities was substantially higher in STEM fields than the rate among white males. Some studies suggest that African-American students are twice as likely to switch from the STEM field than their white classmates (National Academy of Sciences, 2011). The lack of difference in persistence among genders and races in this study is, again, likely related to SES and the educational level of parents. Previous studies have shown that students with parents who have high educational aspirations are more likely to succeed in STEM regardless of race (Hong & Ho, 2005; TIMSS, 2011). This relationship is likely due to the instilling of higher educational expectations and confidence. In this study, most students expressed a strong self-belief in their academic capabilities. This was true regardless of gender or race and regardless of whether or not the persisted within biology.

**Results and the Theoretical Framework**

This study utilized Expectancy-Value Theory as a theoretical framework. This theory states that student’s choice, persistence, and performance is linked to their beliefs about how well they will perform within a subject of study and how much they value the subject (Atkinson,
1957; Eccles Et al., 1983, Wigfield & Cambria, 2010). According to Guo Et al. (2015), task-value beliefs and academic self-concept directly influence achievement choices, performance, effort, and persistence within the STEM field. Therefore, students who value a subject and exhibit strong belief in their ability to succeed in an academic task will exhibit a higher rate of academic success and persistence than students who do not have such beliefs. Within this theoretical framework, beliefs and expectations both influence student success and behavior and must be distinguished from each other so that they may be treated as separate variables. Wigfield and Eccles (2000) conceptually distinguish beliefs from expectancies for success “with ability beliefs focused on present ability and expectancies focused on the future. The final variable within the Expectancy-Value theory is value. Students are expected to expend more effort on an academic task, and exhibit higher persistence within a subject if they value that task/subject highly (Eccles & Wigfield, 1995).

In this study, it appears that value, in the form of professional aspirations, are the most important factor influencing persistence in biology. Students who feel that biology is important for them to achieve their career or professional school goals are more likely to persist. While students entering college as premed vs. non-premed persisted at the same rate, those who changed their mind about med school were more likely to switch to another major. This suggests that biology departments should do a better job of promoting alternate careers in biology. These value measures fit with the “value” aspect of the expectancy-value theoretical framework. However there was no difference between switchers andpersisters according to self-concept variables (except for confidence in lab courses). These have been shown in previous studies to have a great impact on persistence (Wigfield & Cambria, 2009; Shedlosky-Shoemaker & Fautch, 2015). The reason for the lack of variance in this study is likely due to the high socioeconomic
status of the study group. As stated above, SES has been shown to have a strong impact on educational aspirations, self-concept, and achievement (TIMSS, 2011; Guo, Et al, 2015). Essentially, the “expectancy” variable of the expectancy-value theory is held constant in this study due to the high SES of the participants. This suggests that SES is the most important factor influencing student self-concept, belief, and educational aspirations, overriding gender, and nationality.

**Suggestions, Recommendations**

Among biology majors at Northeastern University, the most important indicator of persistence is value. Students who value biology as important in attaining their future goals are more likely to persist. This study suggests that students who are invested in applying to medical school are more likely to persist within the biology major. Students who change their mind about medical school are likely to leave the major as they no longer see biology as important to their long-term goals. This is not unique to premeds as non-premed students who do not feel that biology is important to their future goals are also more likely to switch. One reason given in the open response portion of the questionnaire was a lack of interest in lab-based research and “bench” work. It is apparent that these students are either unaware of the career options in biology or they have not embraced biology as part of their overall identity. Early intervention strategies that build self-identification within the biology major may be effective in increasing retention among theses students. Previous work has shown that intervention strategies that focus on both learning and professional identification are effective in increasing persistence (Summers & Hrabowski, 2006). Both learning and professional identification increase student confidence and effect motivation (Graham Et al., 2013). Students in such programs identify more strongly
as scientists. Identification is linked to value judgments (Eccles, 2005), therefore increasing self identification as a biologist is likely key to increasing persistence by targeting student valuation of the major. Specific strategies identified in the research include; early research experience, active learning in introductory courses, and membership in STEM learning communities (Graham Et al., 2013).

Hippel Et al. (1998) found that students who participated in research within the first two years of college persisted at a higher rate than those that did not have such experience. Research courses have been shown to be an effective way to incorporate research into the early stage of a college science curriculum (Olson & Riordan, 2012). In addition research courses introduced at universities such as the University of Austin have proven to be as effective as research in a faculty lab in increasing student self-identification as scientists and, hence, persistence through increase value measures (Graham Et al., 2013). The introduction of a research course within the first year of the biology curriculum may be effective in achieving this goal. The NU biology department is currently testing a laboratory-based course focused on teaching biology lab techniques. This course is suggested to students within their first two years and an examination of persistence rates after this course is fully implemented would be an indicator of its efficacy in increasing persistence. It may be necessary to add a greater research component to this course if persistence rates are unchanged.

Active learning in introductory classes has been found to reduce STEM attrition (Haak Et al., 2011). In active learning situations students work to reflect on lecture material and apply it to solve a problem posed by the instructor. The goal of this is similar to that of research courses; increasing student self-identification as biologists. The NU biology program requires a course titled “Inquiries in Biological Sciences” during the freshman year. This course breaks the large
freshman class into small sections (approximately 40 students) so that active learning may be applied in a more manageable class setting. As of this writing, this is still a relatively new class. Retention data since its inception will not be reliable until a larger sample size is obtained. However, this course may prove integral in retention. In addition, this course may be ideal for communicating the vast career paths and opportunities available to those with a biology degree. This would serve as a potential intervention for those who switch from premed and no longer value biology or those who express ignorance about their career options as biology majors, thus increasing value measures again.

Learning communities are student-centered groups that meet outside class time and possibly independent of any specific course (Light & Micari, 2013). Such communities have been shown to increase feelings of professional belonging and self-identification with the major. The NU Biology department already hosts student professional clubs such as the Biology Club, Biochemistry Club, and Pre-Health Club. Investments could be made in these clubs to increase their outreach to fellow students and increase recruitment. In addition, an investment in honorariums for guest speakers from a variety of biology disciplines could increase awareness of career options for those considering leaving the biology major due to lack of interest in medicine or research. Another possibility for the formation of learning communities exists within the peer-tutoring program with the biology department. Experienced tutors could be called upon with leading study groups for introductory biology course. These could be loosely structured in such a way that student experiences within biology could be discussed in addition to class material. This would again hold the potential to increase student investment within the major and, subsequently, valuation of the major.
Another intervention strategy that has shown promise in increasing student retention is peer mentoring. Evidence suggests that a well constructed and managed peer mentoring program is an effective tool for increasing student retention and promoting intellectual development of both mentees and mentors. This is exemplified within the literature from consensus drawn from five points about mentoring programs and relationships (Jacobi, 1991). The first is that mentoring is a helping relationship with the goal of increasing student achievement and that this relationship may be formal or informal. The second is that the mentoring relationship includes any or all of the following components: emotional support, professional development, and role modeling. The third is that mentoring is a reciprocal relationship. The fourth is that the mentoring relationship is a personal relationship. The fifth and final point of consensus is that mentors have greater experience, influence and achievement that protégés.

Studies into mentoring programs disagree on whether informal or formal mentoring programs are more successful. In an informal mentoring relationship protégé’s gravitate towards and choose mentors on their own. The prevalence on these types of relationships and their impact is not known because of a lack of reporting (Jacobi, 1991). This is further complicated by the possibility that the sample may be biased as it may be the higher quality students that seek informal mentoring (Jacobi, 1991). Formal mentoring, in which students are actively matched with a mentor has been more studied and there is much more data available. Most of the work referenced in this review is based on studies of formal mentoring programs.

Inzer and Crawford (2005) studied the effectiveness of formal mentoring versus informal mentoring. Their study concluded that informal mentoring is a natural outcome
of relationships between members of the same society, school, or workplace. The relationship may be initiated by either the mentor or the mentee with the mentor identified as a trusted person from whom the protégé can gain wisdom. From this, the informal mentor/mentee relationship is defined by Inzer and Crawford as one between two people where one person gains “insight, knowledge, wisdom, friendship, and support” from the other. The authors, then turn their attention to formal mentoring. They list six benefits of formal mentoring within organizations. These include: learning the politics of an organization, understanding societal norms, understanding accepted standards, understanding common values, understanding organizational ideology, and learning about the history of the organization. These six categories are heavily related to the success of an individual within a specific organization and would therefore be of more value to the successful functioning of the organization and not necessary the personal development of the mentee. This leads to the understanding of formal mentoring as a business practice as opposed to an educational practice. This is certainly the case if one looks at mentoring programs as merely a tool for student retention and may explain the proliferation of formal mentoring programs at universities despite the evidence of Inzer and Crawford that suggest that informal mentoring programs are more beneficial for the personal, intellectual, and professional growth of mentees.

Cotton, Miller, and Ragins (2000) also studied formal mentoring and informal mentoring. Their conclusions are not a stark as Inzer and Crawford (2005). They note that some of the reported dissatisfaction of mentees in a formal mentoring program may be due to the skills and commitment level of the mentors. This is less of a factor in informal tutoring because mentees are free to choose their own mentors and will tend to gravitate
towards individuals are the best match. In comparing informal mentoring programs the authors reported the following:

1. Both formal and informal mentoring can be effective and beneficial.
2. Informal mentoring is better than no mentoring.
3. Mentees in effective formal programs have a more positive attitude than those in less effective programs.
4. Mentees in effective formal mentoring programs reported it as a positive experience.
5. Programs with guidelines for meeting frequency were more effective.
6. Programs in which the mentor joined voluntarily were more effective.
7. Good mentoring leads to positive outcomes. Bad mentoring can be destructive and worse than no mentoring at all.
8. Even the best program, whether formal or informal, can not succeed if the mentors are of poor quality.

While referencing the work of Cotton, Miller, and Ragins (2000), Inzer and Crawford (2005) conclude that regardless of whether a mentoring program is formal informal, some level of formality is required. They conclude that both formal mentors and informal mentors must undergo formal training. This is to ensure a quality experience for the mentee and to avoid points 8 and 9 listed above from Cotton, Miller, and Ragins (2000). They also conclude that organizations should continue with formal mentoring programs because they are easier to maintain and manage in comparison to informal mentoring programs. However, they do stress that more research is necessary in order to incorporate more aspects of informal mentoring into formal mentoring programs.
Another study of informal mentoring was conducted by Erickson et. al. (2009). Their initial data supports the conclusion that mentors can be a significant positive influence on protégés. This was found to be true even when variables such as social background, parenting, and personal resources were controlled. However, it was discovered that a disparity existed in the access to mentors between disadvantages and advantaged youth. Disadvantaged youth were significantly less likely to report having a mentor when compared to an advantaged youth. Further, this study concluded that while informal mentoring is effective in improving educational performance and attainment, it also contributes to social inequality. Disadvantaged youth often lack access to and the ability to attain an informal mentor. This means that advantaged youth are more likely to attain an informal mentor and reap the benefits of such a relationship. This widens the gap between disadvantaged youth and advantaged youth. Erickson et. al. support the use of formal mentoring programs that actively match disadvantaged youth with mentors.

There is inconsistency in the research about the role of gender in peer mentoring programs. Early theoretical work into mentoring was gender specific, only looking at males (Levinson et. al., 1978). Despite this restricted data set, this work was widely adopted in industry and education (Budge, 2006). Further work supported gender stereotypes in mentoring research and actively discourage mentoring relationships between males and females (Long, 1994). More recently studies have challenged this approach (Bova, 2000). Brainard and Carlin (1998) found that gender specific mentoring increased the self-confidence and retention among female engineering student. However, more study is need to clearly elucidate the relationship between gender and mentoring. (Budge, 2006).
Problems of race have also complicated mentoring studies. Good et al. (2000) reported that mentoring programs increased retention and success minority students. However, other studies have shown that minority students may be resistant to and skeptical of mentoring programs (Jacobi, 1991). Ehrich (2004) found that many minority groups report a lack of access to peer mentors. In addition, there is often a lack of institutional commitment to providing academic support services for African American students (Horn et al., 2004). Further, the effects of cross-cultural mentoring have been under studied (Johnson-Baily et al., 2004). There is some disagreement in the literature on whether cross-racial mentoring can be effective (Jacobi, 1991). In fact, many organizations strive to provide race-specific mentoring (Jacobi, 1991).

Evidence that supports the positive potential of race-specific mentoring programs is provided by Zell (2011). Zell’s study reports on a race-specific mentoring program that focused on African American male college students in the Chicago area. Seeking to build on literature that indicates that membership in a peer group increases academic persistence and psychosocial development in minority students (Bonner, 2010), Zell investigated the impact of the Brother2Brother program. This program is a peer mentoring program that focuses on academic persistence and social integration for African American males. Zell’s qualitative study found that this race-specific mentoring program had a positive outcome for mentees in several ways. Mentees experienced increases in academic motivation and became more disciplined in schoolwork. Mentees developed better study habits and focused on college graduation as a goal. In addition, peer pressure acted as an effective tool to minimize absences from class and increase in-class participation and attentiveness. “Personal presentation” was another area in which mentees were influenced by their
mentors. B2B participants were encouraged to wear a suit and tie everyday and use professional language. Mentees reported that they greatly benefited from presenting a professional image. They experienced feelings of maturation and self esteem that increased their academic motivation and, subsequently, their academic success. Mentees also experienced validation of their emerging skills. Mentees where motivated and confident enough to become involved in other campus organizations and groups, often taking on leadership roles. In addition, mentees became recruiters for the B2B program, often approaching new students and encouraging them to join the program. Participants also reported an increased sense of personal growth. This stemmed from the program's focus on developing new skills and a sense of responsibility for the success of others in the program. Mentees reported increases in problem-solving skills, resource mobilization, networking, self-organization, and leadership skills. Another area of growth was in understanding the ethic of collaboration. The B2B program emphasized collaboration over competition. This kept mentees engaged and led to a greater appreciation of their racial identity and sense of community. Finally, mentees felt rewarded through accountability, leading to increased personal development. Zell felt that these results, despite a small sample size, provide compelling evidence for the efficacy of peer mentoring for minority students by minority students.

In their study of a peer mentoring program in South Africa, Essak and Juwah (2007) identified five ways that mentors can effectively deal with cultural differences in the mentor/mentee relationship. They conclude that mentors must value cultural differences and promote an “inclusive learning environment.” They also recommend that mentors be ethically aware of matters pertaining to culture, ethnicity, race, and linguistics deficits and
how these factors may impact student learning. Mentors must also be versed in intercultural communication. In addition, mentors should be able to provide “support and effective intervention” to meet the various cultural, ethnic, racial, and linguistic needs of mentees. Finally, mentors should serve as “conduits” through which minority students can access the “cultural capital” of the dominant group.

Studies have shown that specificity in research scope and design is vital for evaluating the influence of peer mentoring programs. For instance, Rodger and Tremblay (2003) raised questions of subject selection in mentoring studies. They found that while mentoring programs did not result in significant improvement in the grades of the general student population, they did provide improvement in students that exhibited academic anxiety. Allen et. al. (1997) also found that mentoring programs are most successful when tailored for the specific careers of students involved. Consequently, students who received effective mentoring that is specific to their field are more likely to become mentors themselves (Allen, et. al., 1997). Further, Durkin and Main (2002) also found that first-year students benefited most from discipline-based mentoring in study skills.

This problem is significant at both the general and local level because peer mentoring programs may, in fact, be an effective tool for identifying at risk students and giving them the skills to approach their course material effectively and therefore succeed. (Terrion and Leonard, 2007) Mentors can use their personal experience to teach the most effective note-taking and study techniques for each subject. They will also have an understanding of what topics a student is likely to see again in future classes. Mentors would also be able to share time management techniques that they have found to work in the past. This is especially important today given all the distractions available to students.
Some studies have shown inconclusive results from mentoring programs (Rodgers and Tremblay, 2003). However, if successful, programs of this nature will increase student retention rates within higher education institutions (Terrion and Leonard, 2007).

Mentoring has been found to be beneficial for both protégé’s and mentors (Jacobi, 1991). Ehrich, et al. (2004) found that mentoring is beneficial for both career advancement and psychosocial support of protégés. They also found that mentors experienced a rejuvenation of their careers as a result of taking part in the mentoring process. Ellinger (2002) also reports that mentors benefit by building a professional network and increasing personal satisfaction.

Essack and Juwah (2007) studied an peer mentoring program at a university in South Africa and received feedback from both mentors and mentees about what they felt were important elements of a successful mentoring program for first year students. Mentors suggested that first year university students needed to be “steered in the right direction.” Mentors felt that first year students did not understand the kinds or pressures and influences they would encounter in college. Mentoring can be used to enact a process of “gradual acculturation” in which students can become adjusted to college pressures and rigor while avoiding the pit-falls inherent in the personal freedom they have acquired in college. This can be accomplished if the mentor acts as a positive example through action. Another area that mentors identified as a need in first year students was the need to learn how to access the “content and canon” of academia. Mentors reported that mentees lack the awareness of the “world of the institution” and academia. Mentors felt that mentees saw higher education as existing at two levels. The first was the level at which they could pass a test or assignments in a “mechanistic” fashion. The second level was one in which
they could find, gather and incorporate knowledge. At this level mentees should be able to synthesize knowledge for their own intellectual development. Mentors in this study assisted in attaining both of these levels. This was accomplished, first by teaching mentees how to access and utilize the mainstream information sources, thereby attaining the first mechanistic level. Once this had been accomplished, mentors were able to help mentees attain the second level by engaging them in higher level discussions, either in person or by electronic communication. Feedback from mentees was reported by ranking the perceived importance of the various elements of mentoring. The majority of mentees (76%) ranked academic mentoring as the most effective and useful element of a mentoring program. Personal and social mentoring were deemed of lesser importance (both ranked as most important by only 12% of mentees). However, personal mentoring was ranked as second in importance by 52% of mentees. Social mentoring was ranked as second in importance by 44% of mentees. This suggests that all three mentoring roles are of some importance and lead to positive outcomes for mentees. In fact, Essak and Juhaw conclude that due to the overlapping nature of these three tutoring elements, both personal mentoring and social mentoring are pre-requisites for academic mentoring.

There is, however, evidence of potential drawbacks to mentoring programs. The “dark side” of mentoring programs has been poorly reported (Jacobi, 1991). However, evidence does exist that there is a down side to mentoring programs for both mentees and mentors. The majority of these problems stem from a lack of organizational support (Jacobi, 1991). Hansford, et. al. (2003) found that a lack of funding for mentoring programs can restrict student access to mentoring programs. A lack of time committed to mentoring and a lack of proper management also negatively affects the viability of mentoring
programs. This problem can be widespread. Vicki et al. (2003) found that 98% of students in the medical field reported a lack of available mentoring as a hindrance to professional development. Ellinger (2002) reports on the negative impacts the mentoring may have on the mentor. These impacts may include, a loss of time for personal development, professional jealousy, overdependence of mentees, and unwanted romantic entanglement. In addition poor matching of mentor with mentees can lead to a poor experience for both (Ehrich et al., 2004).

Mentoring programs must be well organized and managed. Unfortunately, there is still much left unanswered about the efficacy of different peer mentoring program structures. Further research into the complex nature of the mentor/mentee relationship is necessary. One recent study by Jones and Corner (2012) attempts to do just that. They have approached peer mentoring from an ecological approach that acknowledges the various, interconnected factors that affect it. They recommend that all future mentoring programs be designed with their environmental factors in mind. Shaheeda (2008) also looked at mentoring from an ecological perspective. She posed three questions to mentors and mentees in order to investigate the effect of environmental factors on the success of peer mentoring. First she asked, “How does peer mentoring act to invite or inhibit particular responses from the environment?” In response to this, both mentors and mentees reported that the mentoring relationship enhanced positive behavior and repelled negative behavior by promoting mentee development within a new environment. The second question was, “How do mentor/mentees characteristically react to and explore their surroundings (‘selective responsibility’)?” It was found that mentors help mentees to structure their activities to be beneficial towards exploring their surroundings in a
beneficial and positive way. The third question was, “How do mentor/mentees engage or persist in increasingly complex activities, including reconceptualizing and creating new features in the environment, for example, when mentor/mentees seek out activities that require increasing levels of critical thinking and the differences thereof (‘structuring proclivities’)?” Highly competitive environment of higher education, mentoring in the academic domain was more useful than in the social domain. Academic mentoring increases the success and persistence of students in this environment to a higher degree than social mentoring as perceived to do.

It is recommended that any peer-mentoring program undertaken by the Biology department at NU adhere to the following guidelines: Peer mentoring programs must be formalized to some degree to ensure equal access to mentors for all students, regardless of race, ethnicity, and gender.

1. Mentors should mirror the student population in racial, ethnic, and gender make-up.
2. Regardless of the demographic make-up of the mentors, they should be sufficiently trained in cultural sensitivity.
3. Regular academic training must be required for mentors.
4. Regular mentor/mentee meetings must be mandated by the program.
5. Informal contact between mentors and mentees should be encouraged.
6. Mentors should meet regularly with other mentors to discuss their experiences and share their successes and failures.
7. Regular feedback should obtained from mentees so that any ineffective mentor relationships may be repaired or replaced.
Limitations and Areas for Future Research

This study was unique in the literature of persistence within STEM as it focused on a population that was heterogeneous in gender, race, and nationality yet homogeneous in SES. This was illuminating in illustrating the influence of SES in shaping student self-concept and expectancies, however it was limiting in achieving a larger picture of the role of student attitudes in persistence within biology. Future research should focus on comparing SAQ measurements between difference types of schools. It would be useful to compare an urban, exclusive, private institution, such as NU with other schools such as state schools, rural schools, and community colleges.

Another limitation of this study was the discrepancy in sample size between persisters and switchers. Persisters were more represented in this study because they were a “captive” audience, sampled during a required class in their biology curriculum. Switchers were contacted via email and had no obligation to fill out the SAQ. Thus, the response from switchers was no nearly as comprehensive as that of persisters. In future research, it would be useful to develop a more reliable method of sampling switchers.

Despite the stated limitations, this study does provide useful information about student persistence choices and attitudes. Future research could build on this in two ways. First, the development of intervention strategies designed to identify students likely to leave the biology major due to low valuation of the major and a lack of knowledge of career options. Biology should be seen a more than just a path to medical school or research. Educators in the biological sciences must make students aware of the vast array of career options available to them as biology majors. Research into the best way to accomplish this would be of much use. Secondly,
research is needed into how to instill students from low SES households with the same academic expectations of self confidence as those from high SES households. As stated above, a combination of parental influence and available resources lead to high expectancy values among students from high SES households. Research must undertaken as to how to provide these resources to low SES households and how to empower parents of low SES families to instill high academic expectations and self-concept in their children. In this way it may be possible to heighten both the expectancy and value measures of students interested in biology regardless of their background.
APPENDIX A: STUDENT ATTITUDE QUESTIONNAIRE

Section 1: Background Questions

1. Major __________________________

2. Gender __________________________

3. What was the highest degree earned by your mother? (Circle one)
   - High School
   - College (undergraduate)
   - Masters
   - Doctorate
   - None

4. What was the highest degree earned by your father? (Circle one)
   - High School
   - College (undergraduate)
   - Masters
   - Doctorate
   - None

5. Do you have older siblings? Yes / No

6. If you have older siblings, have any of them attended college or university? Yes / No

7. Do you speak English at home?
   - Never
   - Sometimes
   - Almost Always
   - Always

8. Were you born in this country? Yes / No

9. Were your parents born in this country? (Circle one)
   - Neither parents born in this country
   - One parent born in this country
   - Both parents born in this country
   - Unsure

10. How many books are in your permanent home? Include e-books. (Circle one)
    - 0-10
    - 11-25
    - 26-100
    - 101-200
    - More than 200

11. Did you have your own room while growing up? Yes / No

12. Does your permanent home have an internet connection? Yes / No

13. Do you have your own computer or tablet? Yes / No

14. Do you use a computer or tablet at home? Yes / No

15. Do you plan to attend graduate school? Yes / No
17. Do you plan to attend Medical School? Yes / No

18. When you first entered college did you plan to attend medical school after graduation? Yes / No

19. While you were a biology major, did you do COOP? Yes / No

20. While you were a biology major, did you do work/volunteer in a biology research lab on campus? Yes / No

21. How would describe your ethnicity? ____________________________

Section 2: Attitudes About Biology

Please circle the response that best fits your feelings about Biology.

1. I enjoy learning biology.
   Strongly Disagree Disagree Neither agree or disagree Agree Strongly agree

2. Biology is boring
   Strongly Disagree Disagree Neither agree or disagree Agree Strongly agree

3. I like biology
   Strongly Disagree Disagree Neither agree or disagree Agree Strongly agree

4. Learning biology will help me in my daily life.
   Strongly Disagree Disagree Neither agree or disagree Agree Strongly agree
5. I need to learn Biology to learn other subjects.

Strongly Disagree  Disagree  Neither agree or disagree  Agree  Strongly agree

6. I need to do well in biology to get into the graduate school or professional school of my choice.

Strongly Disagree  Disagree  Neither agree or disagree  Agree  Strongly agree

7. I need to do well in biology to get the job I want.

Strongly Disagree  Disagree  Neither agree or disagree  Agree  Strongly agree

8. I usually do well in biology courses.

Strongly Disagree  Disagree  Neither agree or disagree  Agree  Strongly agree

9. I usually do well in biology lab courses.

Strongly Disagree  Disagree  Neither agree or disagree  Agree  Strongly agree

10. I have good lab skills.

Strongly Disagree  Disagree  Neither agree or disagree  Agree  Strongly agree

11. Biology is harder for me than my classmates.

Strongly Disagree  Disagree  Neither agree or disagree  Agree  Strongly agree

12. I am just not good at biology.

Strongly Disagree  Disagree  Neither agree or disagree  Agree  Strongly agree
13. I learn things quickly in biology.

Strongly Disagree    Disagree    Neither agree or disagree    Agree    Strongly agree

14. I have a better understanding of biology than my classmates.

Strongly Disagree    Disagree    Neither agree or disagree    Agree    Strongly agree

Section 3: Open Response Questions

1. Why did you initially choose to become a biology major?

2. What is your favorite subject within Biology and why?

3. Have you ever considered changing your major from biology? If so, why? What other major(s) did you consider?

4. If you changed your major from biology, what were the reasons for the change?
APPENDIX B: FULL TEXT RESPONSES FOR THE QUESTION: “WHY DID YOU INITIALLY CHOOSE TO BECOME A BIOLOGY MAJOR?”

PERSISTERS

I had a really amazing AP bio teacher in high school who showed me that I could do well in science if I put my mind to it and I love the ocean.

pre-med student, so I started out in bio

I wanted to be an eye doctor

I got good grades in science classes in high school

I did well in AP bio in high school and wanted to take more biology classes and go to med school

I initially chose bio because I was on the fence between careers as a vet and animal trainer. Either way, bio is a good place to start.

I didn't. I was initially anthropology

I wanted to go to medical school

I wanted to be a doctor and I like biology in high school enjoyed learning science. Wanted to be a doctor

I wanted to learn more about life. I found the topic interesting and felt it had good career opportunities

no clue

I always liked science and fell in love with the ocean at a young age, hence the marine bio major

I wanted to cure diseases and do research
I love learning about how things around me function. Always loved biology.

I've always loved science. I knew I'd pursue science after high school. Biology encompassed the topics that interested me the most.

to set myself up for med school

I always knew that I wanted to go into the sciences however it wasn't until recently that I identified neuroscience as my passion.

to go to veterinary school and because I loved AP bio in high school

to go to dental school

it has always been a topic of interest

love the subject, interest in graduate study in the area

I took many science courses in high school, was good at science and enjoyed it. I enjoyed lab and was also interested in psychology and the brain but wanted my studies to be more science focused.

I thought it's interesting to learn about the functions and structures of organisms and relate it back to health/human

the genetics class I took sophomore year was really interesting and convinced me to major in biology.

I did not know what I wanted to major in but I knew I didn’t want to come in undecided because I didn’t like the feeling of "falling behind" (which I put in quotes now because I think it was a bad decision). I like biology because I studied it and had a

It was my favorite subject in high school and I had a great teacher back then who encouraged me to take the bio track

ever since my first HS biology class, I knew I was interested and could do well in
biology

I became interested in the biology major after taking high school biology because science is awesome! I love finding out how life works. I've always had a passion for science, and my father is a doctor, so I would like to follow in his footsteps. It helped to fulfill my requirements for PA school to get accepted to college and because I did well in biology in high school and found it interesting.

In high school I was involved in preclinical research associated with glioblastoma multiforme and biology became the only language I wanted to speak. Life is very complex and has always fascinated me. It has always been my area of interest over other sciences.

I was interested in the subject but wasn't sure what to pursue with it. I started in health sciences major but did not look forward to taking many of the upper level public health-oriented classes required after my 3rd year. I decided to switch to biology because the upper level courses sounded more interesting.

I was a biology major when starting college but in my previous school I was required to take bio principles 1 and had an amazing professor who convinced me to pursue science. Human A&P fascinates me.

I chose to become a biology major upon applying to NU because I liked science in high school and didn't want to start out undeclared. I took biology in high school and enjoyed it.
I wanted to go to medical school and it was the first subject that challenged me and held my interest over a long period of time. I chose biochemistry because I felt it would help me understand living systems at the most fundamental level interested in science. Endless pool of constantly changing knowledge my parents wouldn’t let me be a sociology major (I’m thankful now) and I had done well in AP bio in high school best chance of getting into medical school.
I liked to see what is going on in my body randomly.
I enjoyed learning about biological systems and wanted to pursue medicine I was interested in the brain and really enjoyed and did well in AP bio in high school I loved understanding life on a molecular scale, loved genetics, loved the lab setting via Columbia science honors program and loved science
I initially wanted to pursue a career in research and I enjoyed learning about biology I wanted to go into health sciences but Bouve wasn’t accommodating to new students less science background so bio was the next best thing.
It was the only subject that I thought was interesting enough to study for 4/5 years. Biology is about life and thus it seemed to me to be the only subject worth studying I chose to become a bio major because I was always good in science in HS and I really enjoyed learning about the study of life.
I wanted to go into neurobiology and attend medical school originally looked into engineering but decided it was too rigid. Though neuro would be
a great compromise psych and bio. What’s more interesting than the mind?

Easiest way to graduate with the credits I had previously earned

It was the class I most enjoyed in high school and because it explained the ways the world around and within me work

because is was my favorite subject in primary school

I thought it would be the best major to get me into medical school

I love science

I am interested in medicine and health and the core of this interests lie in biology

medical school

wanted to go to medical school

wanted to work in a lab

I liked it best in high school and saw myself enjoying learning about it for a long time

I enjoyed science and I was initially planning on attending medical school

always liked the subject

life science tool AP bio and enjoyed it decided on bio

I knew I wanted to be a scientist and it was my favorite field of science and very interesting to me

I wanted to be a doctor or teacher and biology was the subject that I always wanted to put effort into and always did well in

came into undergrad wanting to become a virologist and develop vaccines

go to medical school after graduation

because I wanted to go to med school

I was always good at biology/science in high school
I've always loved bio classes and my parents wanted me to go to med school

I really enjoyed my AP bio course in high school

the degree allowed me to meet premed requirements without using electives

medical school

prereqs for vet school

I was good at biology in high school and enjoyed the subject

Wanted to study a science that had concrete visual stuff

Med school requirements

entered undeclared but interested in bio declared marine bio. After first coop realized I

liked industry work and switched to bio

interest since young age

Because I really like science and the human body and life sciences and I thought it

would set me up well for med school

interested in science, desire to go to med school, did well in science in high school

fit with the courses needed for med school

it was the subject that interested me the most in high school and I knew I was interested

in a career in medicine

because I struggled with biology more than any other course in high school I welcomed

the challenge also important for pre med

high school, interest

I did well in AP bio and figured I would go to med school. That changed fairly quickly

always been fascinated with the study of life and love learning about how life works

wanted to go into research
biology provides an good foundation for a career in health care (med school)

love AP bio in high school

I came to nu as a bio major because it was my favorite subject in high school it was the only subject I could imagine pursuing
came in as a journalism major

I wanted to into engineering but AP biology in high school changed my perspective also I was diagnosed with Crohn’s disease which pushed me towards a degree in medicine

my second year of college
med school

I wanted to go to med school and though this was the most straight forward major to choose

I enjoyed learning about it in high school
I always liked it in grade school and decided to continue
always found bio interesting
premed and only class I enjoyed
I always knew in high school that I would be a biological sci major
biochem because best of both worlds (bio and chem) makes it easier to get into more careers
didn't want to sit in a cubicle. Like science
always interested in life sciences and made sense for premed
SWITCHERS

It was a good mayor to fulfill my pre med requirements

To pursue medical school

Wanted to go into medicine

I chose biochemistry because I wanted to take a balance of biology and chemistry courses

I was initially pre-med and thought Biology was a good major to have for pre-med requirements

I chose BNS because I am interested in the brain and how it works on a functional level. I also wanted to pursue research, and thought BNS would help me get to where I wanted to be.

I've always been interested in the medical field, and biology and chemistry were my favorite subjects in high school.

I enjoyed studying about life sciences in high school and hadn't really considered the somewhat limited job opportunities (mostly research and lab work) in the biochemistry field.

I did well in High School and thought it was interesting

I was interested biochemistry because of the mixture of the two subjects. I didn't like either entirely, but when I studied biochemistry for a short time in high school I really enjoyed it.

While applying for college, majoring in Biology seemed to be the only clear route when it came to thinking about career choices. At the time, I wanted to be a doctor.

I wanted to be a bns major so that I could mixed both bio and psychology but it was so
heavily weighted with bio

I enjoyed biology in high school and it was my favorite science.

I did well in both biology and chemistry in high school, so I decided to major in biochem.

I love to know the way things work, how my body works, and understanding how it all comes together.

I was largely interested in neurolinguistics. The BNS program seemed like a great start to get the background necessary in neuroscience.

I wanted to be a vet

To prepare for Medical School

I wanted to be either a pediatrician or psychiatrist

Biology fascinated me, and I loved learning about how life worked, down to the cellular level.

I was largely interested in neurolinguistics. The BNS program seemed like a great start to get the background necessary in neuroscience.

Was something I did well in in high school, had to apply to a specific major to apply to northeastern

I wanted to be a vet

To prepare for Medical School

I wanted to be either a pediatrician or psychiatrist

Biology fascinated me, and I loved learning about how life worked, down to the cellular level.

It was interesting in high school, and remains interesting to this day

I was on the pre-med track so I assumed that was the best/only route before I learned about other options.

I chose to be a BNS major because I enjoy studying the mind and brain

I loved medicine. I loved learning about how different things in our body work

I don't really know. I received an award at my high school for overall best student in Science - I always did pretty well in my science courses and I guess I was thinking about going to medical school back then.
Interest in living things

I was interested in the biological factors underlying psychopathology.

I was interested in med school and had a passion for biology from high school.

To pursue a career in forensic science

I wanted to go Med school

i wanted to help people heal.

I like it/I want to become a physician.

I got very good biology and anatomy/physiology grades in high school, was an EMT for two years, and wanted to attend medical school.

I wanted to pursue a career in lab work.

It was both easy and interesting to learn about.

BNS sounded interested when I applied to NU but I did not know what the major entailed.

I thought it was the right thing to major in for my intended path in grad school.

I excelled at high school biology and really enjoyed learning about the topic.

In high school, I really liked my science and math classes. I wasn't quite sure at the time what I wanted to do as a career so I thought I would start with Biology and go from there.

I had ambitions to attend medical school to become a pediatrician.

It was interesting to me and I saw in BNS especially an opportunity for exciting new areas to eventually research.

To get into medicine and healthcare.

I wanted to be a Veterinarian
Was targeting pre-med; decided against it.

I enrolled as a Marine Bio Major because I love the ocean and wanted my college career to be related to ocean sciences

Because I wanted to go to medical school for psychiatry

I love Biology and it sounded cool
I am not very interested about studying animals. Also I wanted to take more non science classes specially in the public health area. Also, the coops offered in this department did not seem interesting for me (too much lab, I wanted more patient interaction. I am no longer interested in medical school and am now looking at rehabilitation and recreational therapy.

I decided I no longer wanted to pursue a medical career.

I decided I didn't want to go to medical school or pursue a PhD so I started looking for other career options and more suitable majors.

I changed my track to pre-PA and the Health Science major better covers grad school requirements.

I decided that a Psych major with a BNS minor would be better for pursuing clinical care or research involving human participants, which was where my focus was shifting.

I would also be lying if I said my aversion to taking organic chemistry wasn't a fact. My aim is to get into prosthetics, so I needed to switch into engineering.

I decided that the post-graduation path for the sciences was too narrow, and I realized that I wanted to go into more general health sciences revolving around health advocacy and possibly health policy.

Many reasons. I don't know what I would do with a Bio Degree, I wasn't doing well, and I was bored with the classes (Not that business is more interesting).
I realized I was not interested in lab work/research at all.
I decided to leave the biology major because I decided I no longer wanted to become a doctor.

The biology curriculum seemed set up for students looking to take the MCAT and go to medical school. I am more interested in research and was also interested in geology because I can study the chemistry that I was more interested in without having to take biology classes.

I wanted to directly apply biology to patient care, so I switched to Nursing.

I did very poorly in the general level intro biology class. I tried very hard but something wasn't clicking. I also switched because I thought the Linguistics/Psychology major was a smarter decision for what my career goals were at the time.

Psychology was a better fit; it was too difficult/demanding and the passion wasn't there.

I couldn't handle the Chemistry requirements.

I changed career paths.

While I enjoyed learning about biology, I felt constricted in my future career choices, and since I didn't want to be a doctor or work in a lab my whole life, I switched out of that path. I also found my love for art during that stressful time of deciding.

To me, it was becoming clear that there were two jobs associated with a Biology (or related) major: Healthcare and Lab work. I do not like hospitals, and I hate sitting alone in a lab and not talking to anyone. I am fascinated by biology, but the stagnant The courses required began to move away from my interests and didn't seem as applicable to what I wanted to do in the future (for example I want to go to PA school
and enter the health field so more years of calculus in biology didn't seem as important as

It was too difficult and the requirements for the BNS major were ridiculous. I realized my interests and my career path didn't need the biology aspect of the major.

I always wanted to be an entrepreneur. That was one of my favorite areas, which is why I thought of pursuing it for some hard skills. Bio wasn’t giving me something I couldn’t study on my own and I couldn’t handle the rest of chemistry. Chemistry alone was a

I questioned why I was in it in the first place. Had no desire to work in a lab. The potential co-ops did not appeal to me at all. I knew that in order to make any kind of decent career out of it I'd have to stay in school for so long, and that was not wo

Wanted a harder major with a more clinical focus

Became more interested in the cognitive factors underlying psychopathology

I realized I didn't want to be a doctor and that I didn't want to do lab work.

I did not enjoy biology and came to realize I was better suited for study of the social sciences

It was just hard for me to fully understand and retain all the information

I left the bio major because i felt that though the material was very important. I felt that i was being forced to learn information that was not practical towards what my end goal. I wanted to pursue becoming a MD but felt discouraged as it seemed that t

I thinks a chemistry degree is more practical

After taking chemistry and calculus, I realized I didn't want to continue for 4-8 years.

Biology was still interesting, I just realized I didn't want it as a career.

I wasn't doing well and didn't like the coop options.
My goal is to work clinically and BNS did not provide that opportunity. I intend to go to grad school for pediatric occupational therapy. After looking into grad programs more, I realized that the majority of the prerequisites were psychology courses, with only one biology prerequisite. For that reason, I chose to switch my major. I missed learning about math and physics, and the biology major just didn't have enough of these classes to satisfy me. I was unaware of all of the possible careers associated with a Biology major. I struggled with the material enough where I knew I would not make it to medical school and decided to change my career path. I could not see myself in a research position and that is what I would have ended up doing with my biology degree. Ultimately, my passion is for English literature and I could not see myself working in the sort of job for which the BNS major prepares you. I wanted to be hands on with patients and people, did not enjoy working in a lab, felt that BNS led only to research or medical school. Part of the reason was that I had C's in most my biology courses. But the main reason was that I was getting C-‘s and D's the pre-req courses for Vet school e.g. Orgo, Physics, Calc, BioChem. It seemed like the sciences weren't for me. Also I didn't want to place stronger focus on chemistry; however, I have ultimately decided to do a PhD in Biological Chemistry. To me, Marine Bio at NEU seemed to be researched-focused, as in the curriculum had many micro-bio courses and seemed to encourage students to go into research. I realized my freshman year I was more of a "big picture" person who hated the idea of having a
I became interested in criminal justice/law/public policy

Intro to Chemistry showed me I would never do well in it
APPENDIX D: IRB APPROVAL AND CONSENT DOCUMENT

UNSIGNED CONSENT DOCUMENT FOR WEB-BASED ONLINE SURVEYS

Northeastern University, Department of: Education
Name of Investigator(s): Dr. Bryan Patterson—Principal Investigator, Aaron Roth—Student Researcher
Title of Project: STEM Trends In Higher Education: A Comparative Study Of Student Attitudes As Persistence Factors Among Biology Majors.

Request to Participate in Research
We'd like to invite you to participate in a web-based online survey. The survey is part of a research study whose purpose is measure the influence of student attitudes on persistence in biology. This survey should take about 10 minutes to complete.

We're asking you to participate in this study because you changed your major from biology. You must be at least 18 years old to take this survey.

The decision to participate in this research project is voluntary. You do not have to participate and you can refuse to answer any question. Even if you begin the web-based online survey, you can stop at any time.

There are no foreseeable risks or discomforts to you for taking part in this study.

There are no direct benefits to you from participating in this study. However, your responses may help us learn more about the affect of student attitudes on persistence.

You will not be paid for your participation in this study.

Your part in this study will be handled in a confidential manner. Any reports or publications based on this research will use only group data and will not identify you or any individual as being affiliated with this project.

If you have any questions regarding electronic privacy, please feel free to contact Mark Nardone, NU’s Director of Information Security via phone at 617-373-7901, or via email at privacy@neu.edu.

If you have any questions about this study, please feel free to Aaron Roth, roth.aa@husky.neu.edu, the person mainly responsible for the research. You can also contact Dr. Bryan Patterson, b.patterson@neu.edu, the Principal Investigator.

If you have any questions regarding your rights as a research participant, please contact Nan C. Regina, Director, Human Subject Research Protection, 960 Renaissance Park, Northeastern University, Boston, MA 02115. Tel: 617.373.4588, Email: n.regina@neu.edu. You may call anonymously if you wish.

By clicking on the survey link below you are indicating that you consent to participate in this study. Please print out a copy of this consent form for your records.

http://

Thank you for your time.
Aaron Roth

APPROVED
NU IRB # 42-15-67-02
VALID THROUGH 4/15/16

Northeastern University - Human Subject Research Protection
Rev. 3/28/2014
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