STUDENT ATTITUDES TORWAD SCIENCE AS A RESULT OF TEACHER FEEDBACK

Katharine D. Singer

A Thesis

Submitted to the Graduate College of Bowling Green State University in partial fulfillment of The requirements for the degree of

MASTER OF EDUCATION

August 2010

Committee:
Dr. Tracy Huziak-Clark
Dr. Lena Ballrone-Duran
Dr. Eric Worch
ABSTRACT

Dr. Tracy Huziak-Clark, Advisor

The study investigated undergraduate student attitudes toward science as a result of teacher feedback. Classroom observations were conducted to answer how students react to teacher feedback, attitudinal surveys were administered to collect current attitudes toward science, and individual interviews were completed to gather information about how teacher feedback affects student attitudes toward science. The observations and interviews were analyzed using a coding scheme to find similar patterns and themes. Assertions categorized the themes and warrants were included to support the claims. The survey data were analyzed by calculating the average number of responses and graphed in a bar chart. The three methods of data collection revealed that positive oral feedback increased student participation in the classroom, current attitudes of students toward science is developed as a result of their previous science experiences and the attitude of their science teachers, and student attitudes were increased as a result of teacher feedback.
Dedicated to:

My family and friends

With love and appreciation for helping me realize I can do anything
ACKNOWLEDGEMENTS

I would like to acknowledge the people who helped me during the thesis process. Each one of these people supported and encouraged me to take on a thesis and to create a wonderful piece of work. I have spent countless hours, several months, and numerous tears developing this thesis. My family, friends, and faithful faculty members were always there to support me through the difficult times. There were times I doubted my abilities to actually start and finish a Master’s thesis, but these people never once doubted my abilities.

I would like to thank Dr. Eric Worch, Dr. Lena Ballrone-Duran and Dr. Tracy Huziak-Clark for their devoted time on my thesis. Each one helped me stay motivated and always believed in my abilities to be successful. I am forever grateful for their help and dedication. My friends from the graduate program also deserve many thanks, for they were always willing to help me. I appreciated their time, suggestions, and most of all their encouragement. My brother also warrants my gratitude for his encouraging and loving words of wisdom that always lifted my spirits. I also want to thank my loving boyfriend for always believing in my abilities to achieve a Master’s degree.

Most importantly, I owe my mom my deepest appreciation because it was her who always encouraged me to pursue my dream of teaching. She has always believed in me and has never stopped. She has given me the determination to accomplish anything I put my mind to and she is always there for me to talk to. There were times I thought I could not accomplish a Master’s degree and because of her love and support I will achieve my Master’s in Education. Thank you to all for believing in me and helping me to achieve my lifelong dream.
## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>TABLE OF CONTENTS</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CHAPTER 1: BACKGROUND</strong></td>
<td>1</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>STATEMENT OF THE PROBLEM</td>
<td>1</td>
</tr>
<tr>
<td>PERSONAL RESEARCHER INTEREST</td>
<td>2</td>
</tr>
<tr>
<td>RESEARCH QUESTIONS</td>
<td>3</td>
</tr>
<tr>
<td>PREVIEW OF CHAPTERS</td>
<td>4</td>
</tr>
<tr>
<td>DEFINITION OF TERMS</td>
<td>4</td>
</tr>
<tr>
<td><strong>CHAPTER 2: LITERATURE REVIEW</strong></td>
<td>5</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>5</td>
</tr>
<tr>
<td>RETENTION PROGRAMS</td>
<td>6</td>
</tr>
<tr>
<td>MENTOR RELATIONSHIPS</td>
<td>7</td>
</tr>
<tr>
<td>GENDER DIFFERENCES IN STEM RETENTION</td>
<td>8</td>
</tr>
<tr>
<td>STUDENT ATTITUDES TOWARD STEM</td>
<td>9</td>
</tr>
<tr>
<td>CLASS ATTENDANCE</td>
<td>12</td>
</tr>
<tr>
<td>IMPACT OF FEEDBACK</td>
<td>13</td>
</tr>
<tr>
<td>FUTURE RESEARCH</td>
<td>15</td>
</tr>
<tr>
<td><strong>CHAPTER 3: METHODS AND PROCEDURES</strong></td>
<td>16</td>
</tr>
<tr>
<td>INTRODUCTION</td>
<td>16</td>
</tr>
<tr>
<td>THEORETICAL FRAMEWORK</td>
<td>16</td>
</tr>
<tr>
<td>RESEARCH DESIGN</td>
<td>17</td>
</tr>
<tr>
<td>MIXED METHODS DESIGN</td>
<td>17</td>
</tr>
</tbody>
</table>
Summary................................................................................................................... 30

CHAPTER 4: RESULTS...................................................................................................... 31

Introduction............................................................................................................. 31

Research Question 1: What are students’ reactions to teacher feedback? .......... 31

Classroom Observations ................................................................................ 31

Positive oral feedback increases student participation ....................... 32

Negative oral feedback decreased student participation.................... 36

Summary............................................................................................ 38

Research Question 2: What are current attitudes of students towards science?.... 41

Student Surveys............................................................................................ . 41

Summary........................................................................................................ 44

Research Question 3: How does teacher feedback affect student attitudes toward
science?...................................................................................................................... 46

Student Interviews......................................................................................... 46

Student motivation to do well as a result of oral and written
feedback................................................................................................................... 46

Teacher feedback affects class attendance............................................. 48

Student attitudes develop as a result of teacher attitude and previous
science experiences....................................................................................... 50

Summary............................................................................................ 53

CHAPTER 5: CONCLUSIONS ............................................................................................ 57

Summary of Study ..................................................................................................... 57

Discussion of Findings............................................................................................... 57
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Student Attitudes Toward Biology</td>
<td>42</td>
</tr>
<tr>
<td>2</td>
<td>Student Attitudes Toward Biology</td>
<td>43</td>
</tr>
<tr>
<td>3</td>
<td>Overall Mean of Student Responses</td>
<td>44</td>
</tr>
</tbody>
</table>
CHAPTER 1: BACKGROUND

Introduction

Students majoring in Science, Technology, Engineering, and Mathematics (STEM) are currently in great need. Careers in STEM are flourishing in today’s economy but there are not enough college students graduating with a STEM degree to fill these positions. Science has always been a challenging field of study for me throughout my educational experience. To be successful in a science field one must but forth lots of effort and determination into each course in order to succeed. However, the effort is being attempted by many each year. For instance, Osborne, Simon, and Collins (2003) recorded about 45,000 students enrolled into a biology major in 2000, which is higher than any other science area in the late twentieth century. Thus more students are entering college pursuing a Biology degree than any other STEM discipline. However, the retention rates of students enrolling in STEM disciplines are steadily decreasing after the first two years of college. This has caused a concern to investigate the reasons why students are leaving the STEM disciplines.

Statement of the Problem

The primary problem for STEM disciplines is the attrition rate of students entering into these fields. Attrition, in this study, refers to the rate of students dropping out or leaving the science majors. Students beginning their undergraduate career in science, primarily Biology, tend to leave college or switch to non-science major during the first two years (Walden & Foor, 2008). Recent technological advancements in science and mathematics have increased the need for STEM employees but there is still a shortage of students qualified to fill these needs (Tyson, Lee, Burman, & Hanson, 2007). The main finding from several retention studies is that students
are not feeling connected to their STEM degree and they tend to value a professional relationship between their instructors (McInnes, James, & McNaught, 1995; Tinto, 1997).

The professional relationship was found to increase student motivation to succeed in STEM majors, which was also related to increased student attitudes toward STEM disciplines. The main reason for the increase of student motivation and attitude toward STEM disciplines was instructor feedback. Poulos and Mahony (2008) define feedback as information presented from the teacher that enhances learning and encourages students to develop goals to achieve in future work. The feedback provided by instructors found to increase student motivation to put forth more effort in their work and essentially increased their attitude toward STEM disciplines (Cauley & McMillan, 2010; Iqbal, Azam, & Abiodullah, 2009; Thomas, 2009; Zachris, 2010).

The student attrition rates are still troubling in the United States, despite these significant findings. Therefore the study focused on how student attitudes were affected by teacher feedback in an introductory biology class. The attrition rates have found to be the highest in introductory science courses and biology is the leading science major students are entering (Drane, Smith, Light, Pinto, & Swarat, 2005; Osborne, Simon, and Collins. 2003; Tyson, Lee, Borman, & Hanson, 2007). This concern is important to me as a future educator to find meaningful ways to provide students constructive feedback in order to motivate and encourage them to succeed in science areas.

Personal Researcher Interest

Science was never an area that I was encouraged to pursue in my educational journey. I was not the ‘A’ student in science classes and found myself struggling through assignments and labs more than finding the content interesting and fun. My science teachers did not hold very high expectations for me as a student; just the average student who will get the work done to pass
the class. I often went to my science teachers for extra help on homework and labs and found some clarity but never enough to appreciate science as a potential career.

I recently became interested in science in my college years because I was required to take science courses in order to prepare to teach science in the elementary grades. This was when my interest peaked because the hands-on activities made the content more interesting. Several colleagues were science majors and I began to experience their consistent struggle with their work as I had once experienced. Through conversations with these peers several issues began to surface about science courses that all seemed to focus on a lack of support and encouragement to be successful. My interest started to peak and I wanted to know why these issues were occurring.

My graduate work added to this interest by researching reasons why students are not remaining in the science areas. Several researchers found varying reasons for students leaving the science areas that include science being difficult, students not being prepared for the course load from high school, poor mentoring of students, and the introductory courses’ content is boring and dry (Bachman, Bischoff, Gallagher, Labroo, & Schaumloffel, 2008; Felix & Zovinka, 2008; NSTA, 2009). These reasons have been found to contribute to the attrition rates in STEM disciplines. My lack of interest in science came from a lack of support and encouragement from my science teachers, now the question I pose is how are students’ attitudes toward science affected by instructor feedback?

**Research Questions**

The purpose of this study is to identify how student attitudes are affected toward science as a result of teacher feedback. The research questions are:

1. What kind of feedback are introductory science instructors using?
2. What are the current attitudes of students towards science courses?
3. How does teacher feedback affect student attitudes toward science courses?

Preview of Chapters

The second chapter contains the literature about STEM retention and the various reasons that have been investigated by researchers. The literature reviews the results of retention programs and the impact they had on students, the attitudes of students entering a STEM major, and the impact of instructor feedback on student attitudes and student learning.

The third chapter discusses the research design and data collection and analysis methods used in the study. Included in that chapter are the research design and the procedures of the study. The fourth chapter displays results of the data in tables and charts in order to provide a framework to answer the research questions. The fifth chapter describes the findings and conclusions. In addition, implications and recommendations for future research are included.

Definition of Terms

STEM- Refers to Science, Technology, Engineering, and Mathematic disciplines.

Attitude- In this study, attitude refers to a general positive or negative feeling about science (Rogers & Ford, 1997).

Retention- Refers to the amount of students remaining in science disciplines.

Attrition- Refers to the amount of students leaving science disciplines.

Feedback- In this study, feedback refers to information presented that allows academic improvement (Poulos & Mahony, 2008).
CHAPTER 2: LITERATURE REVIEW

Introduction

A hot issue for STEM majors has been the consistently increasing attrition rates of college students. These majors have been known to be challenging and difficult areas of study but they are in high demand in the workforce. The United States trails all but one other nation in terms of proportion of STEM majors produced at the college level, meaning that about 30 percent of US incoming college freshmen intend to major in these fields (Scott, Tolson, & Tse-Yang, 2009).

There are high numbers of students entering into STEM fields, with Biology being the highest (Osborne, Simon, & Collins, 2003). The issue of attrition begins at the early years of college where students are dropping out of college or switching to a non-STEM major. The reasons vary and are unclear. Several retention programs have been created at colleges and universities to help recruit and retain students in the STEM fields, while some universities help build a community for support and motivation for students.

The number one finding from these retention programs and support networks was that students value constructive feedback from the faculty instructors. Student attitudes were increased toward their STEM major and their academic performance increased as well (Bachman, Bischoff, Gallagher, Labroo, & Schaumloeffel, 2008; Felix & Zovinka, 2008; National Science Teachers Association, 2009; O’Neal, Wright, Cook, Perorazio, & Purkiss, 2007; Pace, Witucki, & Blumreich, 2008). The following sections describe the impact of the retention programs on student retention rates, the impact of feedback on student academic performance, and the impact of teacher feedback on student attitudes toward their STEM major.
Retention Programs

The growing concern of the attrition rates of students in STEM majors caused several universities to implement retention programs. The main focus of these retention programs was to aim at helping students prepare for the college course work from high school. These bridge programs provided incoming college freshmen actual work from introductory math and science courses and help from college instructors. The students worked on lab assignments and homework over the summer in order to prepare for the college courses they would endure in the fall. The students who participated in the summer programs continued into college in STEM majors and increased their attitude toward science (Bachman, et al., 2008; National Science Teachers Association, 2009).

In addition to the bridge retention programs, another attempt at increasing student retention involved building a support network among other STEM peers and instructors. One such support network consisted of requiring all incoming female freshmen majoring in a STEM major to live in the same residence hall, on campus called a learning community. This helped to promote peer relationships since they would see each other in their introductory classes and in the same dorm every day. There were weekly meetings held in the residence halls to discuss the assignments and stress of the workload. The resident advisors were also females majoring in a STEM discipline but who was close to graduating. These advisors were role models for the freshmen females to look up to and model after. After the first year of this learning community the females reported having a positive attitude toward their STEM major and 93.6 percent continued on with their STEM major the following year (Pace et al., 2008).

The main finding among these retention programs has been the impact of feedback on student attitudes toward their STEM major. The instructors from the summer bridge programs
provided one-on-one help with students, which reported increasing the students’ self-confidence level and attitude toward their class (Bachman et al., 2008). The learning community aimed to help increase retention rates for females because they are the highest percent of students leaving the STEM disciplines (Seymour & Hewitt, 1997). The students from the learning community reported gaining more self-confidence to be successful in STEM majors from the mentoring sessions that were held each week (Pace et al., 2008). The relationships built between the mentors and students have found to help retention issues and increase student attitudes toward STEM disciplines.

Mentor Relationships

There are various speculations as to why students leave the STEM disciplines and one of the main reasons is the lack of professional relationship among students and their science instructors. Seymour and Hewitt (1997) found that approximately 40 percent of students who enter college in a STEM major decide to leave within the first or second year of college. These first two years of STEM majors requires students to enroll in introductory courses to lay the foundation of basic STEM knowledge, known as gateway courses (O’Neal et al., 2007). These years are also important for students to establish a professional relationship with the faculty members to build rapport and a support system. Several introductory courses have lab sections that are instructed by teaching assistants, TA’s who help create a comfortable and supportive environment for beginning students.

Students indicated that the lab climate was of high importance to remain in their STEM major (O’Neal, et al., 2007). The TA’s efforts to create a positive learning atmosphere positively impacted the students’ attitudes to perform well in the class. Students who were satisfied with their grade in the class held a positive attitude toward their major and reported they would
continue in their major the following year. Whereas students who were unsatisfied with their grade held a negative attitude toward their major and reported that they did not feel they belonged in science.

The TA’s made an effort to establish a positive learning environment for the students, which ultimately positively impacted the students’ attitude toward their science major and resulted in high academic performance. A professional relationship among the instructor or TA is important for students so they feel connected to their major. Several researchers found that students need to feel a sense of connection with staff members in higher education in order to believe they can be successful at their field of study (McInnes et al., 1995; Tinto, 1997). Instructors who provide additional help sessions and meetings outside of the classroom are able to establish a positive professional relationship with students and ultimately support and motivate them to succeed in their major.

Gender Differences in STEM Retention

Females have been found to be impacted the most from professional relationships from instructors and TA’s because they tend to value feedback from help sessions more than males. At early ages, females tend to rate their math and science ability lower than males even though their achievement levels in these areas are aligned with male achievement levels (Huebner, 2009). Traditionally White and Asian males fill the STEM occupations while women only made up 22 percent of these occupations in the U.S. (Tyson, Lee, Borman, & Hanson, 2007). There have been significant gains of women in STEM fields over the past few years but they are not remaining in the field to receive a degree. The male to female ratio remains high at 3.4:1 in most physics and chemistry majors but females dominate Biology majors with 1.6 girls to every boy (Osborne, Simon, & Collins, 2003).
The higher proportion of females entering Biology majors than males may be a result of rating their math ability lower than males since Biology does not require as much math knowledge as Chemistry or Physics (Huebner, 2009; Osborne, Simon, & Collins, 2003). Females also tend to value constructive and specific feedback from peers and instructors more than males. Providing constructive feedback allows students opportunities to judge their work and correct mistakes to produce high quality work and perform better in their classes (Parker & Baughan, 2009). Male students also prefer to know how they are performing in classes and what they need to correct but females find more value in the feedback to increase their self-confidence and academic performance.

The more constructive and specific the feedback is for students, the more effort students tend to put into their work. Feedback has a strong effect on student motivation and their sense of self-efficacy (Heritage, 2007). The stronger the professional relationship between the instructor and the student, the more likely the instructor will provide constructive feedback to the student, which will ultimately increase the students’ attitude toward the class. The frequency of feedback from the instructor has been found to be highly important to students in order for them to be successful and maintain a positive attitude toward their STEM major.

Student Attitudes Toward STEM

The term attitude is generally referred to a positive or negative feeling about science (Osborne, Simon, & Collins, 2003; Rogers & Ford, 1997). The general public, non-majors, generally do not hold positive feelings toward science and scientists. Gardner, Mason, and Matyas (1989) found that the views of scientists are portrayed as “nerds” or “mad scientists”. The media adds to a negative view of science by presenting scientific achievements as menacing (Sadava, 1976). These negative views can produce fear and science anxiety for students and can
keep them from entering STEM majors (Gottfried, Hoots, Creek, Tamppari, Lord, & Sines 1993). Despite the negative views of science and scientists portrayed by the media, student attitudes toward science are largely developed as a result of teacher influence.

Elementary teachers, in particular, have the largest influence on student attitudes toward science. Bayraktar (2009) and George (2006) found primary school years are the periods where students begin to form their attitude toward science and primary teachers can influence a positive or negative attitude during this time. The attitude of the teacher toward science is passed to the student through different types of feedback on the students’ learning abilities (Cantrell, Young, & Moore, 2003). Teachers with low general teaching efficacy believe they cannot influence student’s motivation and performance in science and thus do not provide positive feedback or provide negative feedback at the primary level. Primary school teachers who posses a low teaching efficacy will likely teach science poorly or withdraw it from their curriculum (Bayraktar, 2009). Poor science teaching or no teaching of science can create negative attitudes in children that they will continue to develop and stray away from STEM areas.

The National Research Council (2007) reported that only seven percent of U.S. degrees were produced at the undergraduate level with only 17 percent of graduate students receiving a degree in STEM majors (Snyder, 2003). These low numbers directly result from negative attitudes students develop toward STEM disciplines because they begin to dislike their science experiences. Students tend to obtain a positive or negative attitude toward science as a result of their science experiences from high school (Moore & Jensen, 2007). The science experiences from high school have a large impact on student attitudes toward higher education science classes. Children tend to leave primary school with ideas about future careers they are interested in pursuing (Silver & Rushton, 2008). Primary teachers who help children develop a positive
attitude toward science will likely continue to develop a positive attitude toward science in middle and high school.

Jarvis and Pell (2002) discovered that interest and enthusiasm toward science decreases with age as students enter middle and high school. The decline of interest also resulted in a decline of positive attitudes toward science. A reason for the decline of attitudes toward science in middle and high school was connected to lack of hands-on activities and investigations in the science classrooms (Bayraktar, 2009; George, 2006; Silver & Rushton, 2008). George (2006) explained that students found interest in the application of science to the real world and this interest boosted attitudes toward science. Bleicher and Lindgren (2005) discovered that pre-service elementary teachers held a more positive attitude toward teaching science when cooperative learning strategies were used where students could work with hands-on materials that related to real world situations. These findings suggest that science classes in middle and high school do not include many hands-on activities and students begin to lose interest in the science areas.

A student who enjoys science and finds it interesting will likely have a positive attitude toward science and students who do not enjoy science will have a negative attitude (Moore & Jensen, 2007). According to Bayraktar (2009), students who dislike science believe it is difficult and that they cannot possibly be successful, resulting in a negative attitude. Students with positive attitudes find science to be enjoyable and they do not want to miss a single science class. These beliefs are manifested in primary grades and can be altered according to the attitude of secondary science teachers. Again, science teachers who possess a low teaching efficacy will likely teach science poorly, influencing negative attitudes to students (Cantrell et al., 2003). The science classes in high school have found to be a major factor for students to decide to pursue a
STEM career in college (Moore & Jensen, 2007). Mostly students who enjoyed their science classes held a positive attitude toward science and found science useful and valuable in the world and thus continued science education. Teacher attitudes found to play a large role in developing student attitudes toward science, which also influenced decisions to pursue a STEM degree.

Class Attendance

Attending science classes in high school tends to be valued more in high school than in college, by both the teacher and the students. The more students attended classes in college, the more likely they participated and the more their grades increased (Moore & Jensen, 2007). Students who regularly attend their classes in high school were found to regularly attend their classes in college. Moore (2004) found students skipped science classes more in college than in high school, with an especially high rate of absenteeism, 25 to 50 percent, in introductory science courses. Although Bayraktar (2009) found students who enjoy science would likely attend all science classes, many college students skip their classes.

In high school, students were rewarded for attending classes with extra points or extra credit work. At the college level most introductory science instructors do not reward students for attending classes (Moore, 2006). Students have reported that attending classes is a factor for succeeding in introductory science courses (Thomas & Higbee, 2000). Several studies have reported that students who regularly attend introductory science courses tend to perform better than students who do not regularly attend classes (Moore, 2004; Moore, 2006; Moore & Jensen, 2008). O’Neal and colleagues (2007) reported that students who feel connected to their major and to their classes feel more motivated to work harder because they feel their instructor wants them to succeed. This professional relationship between the teacher and the student found to
motivate students to be successful. The teacher demonstrates a positive attitude toward the students’ academic ability in the class and this positive attitude will likely transfer to the student.

College instructors believe that academic success depends largely upon students’ levels of academic engagement (Jensen & Moore, 2008) which students also believe is associated with attending classes (Moore, 2004). The higher the grade the student receives in an introductory science course, the more their self-confidence will increase and promote a positive attitude toward science (Rogers & Ford, 1997). Establishing a professional rapport between the teacher and the students can help create a positive class climate to motivate students to work hard and be successful in their major. The teachers’ attitude toward the students’ performance ability and the major can impact the attitude of the student. Science teachers who engage students in the class and connect the content to their lives and the world will help develop or maintain positive student attitudes toward science and help increase retention rates.

Impact of Feedback

Feedback, in the general sense, refers to information presented that allows comparison between an actual outcome and a desired outcome (Poulos & Mahony, 2008). Educators provide feedback in various forms to students in hopes of improving academic performance. Andrade and Valtcheva (2009) discovered that the scarcity of feedback in classrooms is due in large part to the fact that few teachers have the time to regularly respond to each student with constructive feedback. Zacharis (2010) and Parker and Baughan (2009) add that class sizes are constantly increasing and more daily requirements are forced upon teachers and as a result feedback is reduced. The importance of feedback is to inform students of areas that need improved in order to be successful. Effective feedback provides clear, descriptive information that tells students the desired learning goals, how they can improve to meet the goals, and where their performance
currently lies in the process of meeting the learning goals (Heritage, 2007). Effective feedback has found to increase student motivation, which also increased student attitudes toward the particular class (Cauley & McMillan, 2010; Heritage, 2007; Huebner, 2009; Parker & Baughan, 2009; Poulos & Mahony, 2008; Thomas, 2009; Zachris, 2010). Motivating students with feedback in science classes could potentially increase attitudes toward science.

Feedback can be presented in many forms; most commonly it is presented orally or in writing. Oral feedback is information delivered by the teacher in the classroom through words or phrases. Cauley and McMillan (2010) found effective feedback includes; “It looks like the extra effort you put into studying has paid off” and “Look how you’ve improved since you tried a different strategy,” (p. 4). Evidence has found that students want to know how they are performing in classes and what they need to correct in order to improve (Thomas, 2009). Providing effective feedback can motivate students to make the appropriate changes to improve and become successful. The most effective feedback was found to be feedback that was constructive, specific, and timely (Cauley & McMillan, 2010; Thomas, 2009). Students reported that they wanted to know what their strengths and weaknesses are for a specified class (Thomas, 2009). Constructive feedback provides individual students specific information about their academic abilities, and positively motivates them to succeed.

Unfortunately, not all teachers have time to provide constructive oral feedback in the classroom (Andrade & Valtcheva, 2009; Parker & Baughan, 2009; Zacharis, 2010). Therefore many teachers provide constructive feedback in writing. Written feedback can increase student attitudes by specifically stating corrections that need to be made on assignments. Feedback has been found to be of high importance with first and second year college students because the transition to college can be difficult to understand what is expected in classes (Poulos &
Mahony, 2008). Positive, constructive feedback can increase student motivation to be successful in introductory science classes, which can result in a positive attitude toward science.

In order for students to receive constructive and timely feedback it is important for them to attend classes. Students are aware that by attending introductory science classes on a regular basis, their academic performance can increase. Science teachers should hold positive attitudes toward science so that the students will hold positive attitudes toward science, and pursue a science career. Motivating and supporting students through positive, constructive feedback and increase student attitudes and help retain students in science majors.

Further Research

Research has found students become interested in science when their teachers hold a positive attitude toward science and provide meaningful lessons to connect the students to the content. Teachers should provide positive feedback to help students improve their academic performance and increase attitudes toward science. Students who feel supported by their teachers to do well in science are more likely to hold a positive attitude and continue studying science. A warm class climate will help create a positive learning environment for students and they will feel motivated to perform well and keep an interest in science. More research is needed to investigate how teacher feedback affects student attitudes toward science. This study collected data about how students react to teacher feedback, what current attitudes are toward science, and how teacher feedback affects their attitudes toward science in hopes of increasing the student retention rates.
CHAPTER 3: METHODS AND PROCEDURES

Introduction

The purpose of this study is to identify how student attitudes are affected toward science as a result of teacher feedback. Classroom observations were conducted in an introductory biology class to document the reactions of students to teacher feedback, a biology attitudinal survey was administered in the introductory biology class to determine the current attitudes of students toward biology, and follow-up individual interviews were conducted with the students to explain how teacher feedback affects their attitudes. Introductory biology was the science course selected to investigate because it is the leading science courses that most students take in a STEM discipline (Osborne, Simon, & Collins, 2003). The data suggests possible solutions to help increase retention rates of STEM students. The research questions are:

1. What are student reactions to teacher feedback?
2. What are the current attitudes of students towards science?
3. How does teacher feedback affect student attitudes toward science?

Theoretical Framework

The study followed an interpretive research paradigm because the data was collected and analyzed through qualitative methods (Wolcott, 2005). Denzin and Lincoln (2000) define qualitative research as, “…situated activities that locates the observer in the world….consisting of a set of interpretive material practices that make the world visible…and these practices turn the world into a series of representations, including field notes, and interviews…” (p. 3). Qualitative researchers describe their interpretations of the data collected in order to make meaning out of the events. The data collection methods for this study require the researcher to interpret the events that were documented in hopes to better understand the subject.
The goal of interpretive research is to achieve understanding of behavior by analyzing social interaction (Wolcott, 2005). The data was collected to document behavior in a social setting without manipulating the natural setting. The behavior was analyzed to find patterns and interpret those patterns for meaning. Further understanding was collected through interviews that support the behaviors from the social setting. Using multiple forms of data collection adds validity and reliability to the results by drawing conclusions from one set of data and supporting that conclusion from another set of data.

The interpretations made about the data are supported through the multiple forms of data collection. Evidence that was found that conflicted with the purpose of the study was documented to establish credibility of the interpretations. Qualitative research describes situations in the perspective of the participants in the research (Mertler, 2009). The descriptions seek to understand the events of the situation by placing the researcher into the culture of the setting being observed (Denzin & Lincoln, 2000). The interpretations of the data are trustworthy and accurate because they are supported through the multiple methods of collection (Glesne, 1999). Therefore, the interpretive paradigm was the foundation that guided data collection and analysis for this study.

**Research Design**

*Mixed Methods Design*

A qualitative and quantitative design was used for this study. A constant comparative method was used to examine the data for recurring events to interpret the data for meaning (Mertler, 2009). This method required constant analysis among the multiple sources of data collection. Descriptive statistics was used to examine quantitative data for interpretations about the status of individuals (Mertler, 2009). A survey research method collected information about
individuals’ current attitude toward science through a questionnaire and then tabulating the responses (Mertler 2009). Three forms of data collection were designed to collect information about how teacher feedback affects student attitudes toward science.

The first data collection method was qualitative observational research to document student reactions as a result of teacher feedback. The observations recorded student reactions when the instructor presented feedback. Next, attitudinal surveys were administered to the students to examine their current attitudes toward science. Finally individual student interviews were conducted to better understand how student attitudes toward science are affected as a result of teacher feedback. The data collected from these three sources were analyzed at several points throughout the investigation for recurring themes that support the claims.

**Observational Research Design**

An instrumental case study was used to complete the biology observations. This kind of case study helps the researcher better understand this particular setting (Denzin & Lincoln, 2000). Observations were used to document student reactions as a result of teacher feedback and describe the setting and the events as they happened. Interpretations were then made from the descriptions to understand why the events occurred. The specific biology class was selected to seek better understanding of the effect feedback has on first year students. An instrumental case study was appropriate to gather this specific information because the class played a supportive role in providing information about the external interest; student attitudes.

**Survey Research Design**

A biology attitude survey from Russell and Hollander (1975) was used to collect students’ current attitudes toward biology. The survey consisted of 14 statements where students rated their feelings toward biology. The survey used a 5-point Likert scale to rate the responses;
Strongly Agree equaled the value of 5, Agree equaled 4, Undecided was 3, Disagree was 2, and Strongly Disagree was worth 1. There were six negative statements and 8 positive statements toward biology and the students chose the response that best suited their feelings.

The survey offered a neutral option because this allowed the respondents to indicate that they truly are neutral or have no opinion. If participants are truly indifferent, this option does not “force” them to choose something that they do not really believe, thus this option avoids collecting inaccurate data (Mertler, 2009). The purpose of this survey was to collect data about student attitudes toward biology by analyzing student responses about their current biology class. This was an appropriate method to utilize because the survey accurately measured students’ current attitudes toward their introductory science course.

**Interview Research Design**

The individual interview questions followed a semi-structured format with pre-established, open-ended questions (Fontana & Frey, 2000). The questions were structured to provide a guide for the researcher to follow to be sure all key topics were answered by the participant. Interviews are very common in qualitative research because it attempts to find a deeper understanding of human perceptions. Participants are able to explain their knowledge to specific events and provide an insight into the subject of interest.

The format of semi-structured questions is asked in the same order to each participant, leaving little flexibility in the order of the questions asked. The responses are recorded according to a coding scheme to examine the key issues or recurring responses among all participants. The interviewer is neutral during the process by never interrupting with his or her opinion of an answer. The results of the interview are valid and reliable because there is little room to impact
the quality of the responses. The individual interviews gathered data on how teacher feedback affects student attitudes toward science.

Setting and Participants

The study took place at a Midwestern University. The classroom observations were conducted in an introductory biology class. The total student enrollment was 74 students with 36 females and 38 males. The class instructor was a White/Caucasian male. He was contacted and informed of the study via e-mail. There were 16 total students who participated in the survey. There were 11 females, three African Americans and nine White/Caucasian, and five White/Caucasian males all over the age of 18. They were informed of the study during their regularly scheduled introductory biology class. All participants were provided a consent form that explained the procedure of the study that they signed to approve participation.

Data Collection

Qualitative Procedures

Observations

A series of structured observations were conducted in an introductory biology class to document the reactions of students as a result of teacher feedback. An observation protocol was created to document the events that occurred in the field. A structured protocol allows the researcher to strictly observe the natural setting (Mertler, 2009). The protocol accurately measured the reactions of students when feedback was presented. The protocol consisted of four columns to document instructor feedback, student reaction, notes from researcher and key moments in the field (Appendix A).

The observations took place Monday, Wednesday, and Friday for two consecutive weeks. The researcher was assigned an empty seat in the back of the room. The classes started promptly
at 9:30am and lasted 50 minutes. The researcher entered the classroom a few minutes before the classes started and exited after the students. The same seat was used to document field notes to remain out of the neutral setting.

The observations carefully watched student reactions to positive and negative feedback. The responses of students, the way they physically reacted, and the class climate were documented during each event. There was no participation from the researcher in order to remain neutral to avoid manipulation of the natural setting. The class atmosphere was noted at the beginning and end of each class session to examine any changes.

**Student Interviews**

Structured interviews were conducted with five randomly selected students from the introductory biology class. The interviews were face-to-face and completed individually at the university. There were 11 semi-structured questions for each participant that was administered in the same order. The interviewer asked one question at a time into a tape recorder and waited for the participant to respond. The process was semi-structured to follow a guided outline of questions in order to address specific interests (Fontana & Frey, 2000). The questions were all open-ended that required an explanation from the participant (Appendix B).

The structure of the interviews leaves little room for flexibility in asking questions, but there were some questions asked that stemmed from the participants’ response. These extra questions clarified the explanation from the participant. The interviews lasted approximately 20 minutes and each participant received a king size candy bar for their participation. The individual interviews focused on seeking understanding of how teacher feedback affects student attitudes toward science.
Quantitative Procedures

Student Surveys

A biology attitudinal survey was used to collect current student attitudes toward biology (Russell & Hollander, 1975). This instrument accurately measures students’ current attitudes toward biology by rating their responses on a 5-point Likert scale (Appendix C). The survey was completed by 16 students before the end of the biology class. The students who did not participate were allowed to leave. The researcher remained in the room to answer any questions the participants had. The survey took approximately 10 minutes to complete. When the individuals were done with the survey, they handed it into the researcher and received a lollypop for their participation.

Data Analysis

Qualitative

Observations

The classroom observations were analyzed using the continuous narrative description technique; where the data is described in rich detail (Erickson, 1987). Narrative descriptions provide readers the experience of the natural setting where the observations were conducted. The descriptions allow readers to survey the full range of evidence on which the researchers’ interpretations were based (Erickson, 1987). The observations were coded to find evidence that either supports or refutes the claim of how teacher feedback affects student attitudes toward science. The coding scheme was used to group data in words or phrases that reflect specific themes or patterns (Mertler, 2009).

The field notes were documented in an observation protocol and typed in a word document after the observations. Quotes and comments from the observations were highlighted.
in two separate colors to identify positive and negative types of feedback and how the students reacted. Positive feedback that resulted in positive student reaction was coded in yellow and negative feedback resulting in negative student feedback was coded in blue.

The evidence from the observations were organized into positive and negative categories and assigned assertions. An assertion is a generalized statement about categories that support or refute the claim through warrants, or direct quotes from the setting (Erickson, 1987). An assertion for the positive feedback was positive oral feedback increases student participation. The supporting warrant for this claim is, “Kids, it’s ok to be wrong or not to know how to do this! That’s why I’m here, but you have to try. That’s the most important thing of being a scientist, you learn from your errors!” (Field notes 4) The assertion for the negative feedback was negative oral feedback decreased student participation. The supporting warrant for this claim is, “Come on kids, wake up! Think about the types of animals that are vertebrates. You can do this, this is easy stuff.” (Field notes 3) The data collected from the observations were described in narrative vignettes in chapter four that adequately describe the setting and events.

Evidence was collected that did not support the claims but is important to include in the narrative vignettes for validity purposes. This kind of evidence is referred to as disconfirming evidence because it refutes the researchers’ claim (Erickson, 1987). The narrative vignettes are interpretations from the researcher that support or refute the claims to the research questions. Chapter four provides the entire description of events from the natural classroom setting.

**Student Interviews**

The student interviews were transcribed into a Microsoft Word document and a coding scheme was used to find similar words or phrases that reflect a specific theme or pattern (Erickson, 1987). The patterns and themes were then organized into categories and assigned
assertions. The interviews were semi-structured that consisted of “real questions” for the participants to respond to. Providing real questions shows the participants that the researcher is genuinely interested in the answers and this can elicit knowledge about the questions that were never anticipated (Maxwell, 2005). Three assertions were found and supported by warrants that answer how teacher feedback affects student attitudes toward science.

The first assertion found was students are motivated to do well in their science class because their teacher uses written and oral feedback. A supporting warrant was, “My biology teacher will tell me good job or that my work is paying off, and it makes me feel good you know.” Another warrant found was, “Oh, I think I like when he writes comments on my labs and quizzes. That way I can go back and read the comments when I’m studying.” These warrants support the claim that students feel motivated to do well in their science class when their instructor provides positive oral and written feedback.

The second assertion was teacher feedback affects class attendance. Supporting warrants for this claim include, “Well, our biology teacher always tells us how we can improve something on an assignment or what to study for the next quiz. And the students who do not go to class will not know about this information, so they’re grades will not be as good.” A warrant found that did not support the claim was, “I don’t think attendance really makes or breaks your grade. Ultimately, the instructor gives you a grade for your work, not to see your face everyday. There are students who come and sleep the whole time, why should those students still pass just because they show up. They clearly do not make an effort to learn.” This piece of disconfirming evidence is important to include because it presents information that should be investigated in future studies.
The last assertion found was student attitudes are developed as a result of previous science experiences and teacher attitudes toward science. The supporting warrants for this claim include, “My high school AP Biology teacher really motivated me to look into science as a career. He was really funny and easy to talk to; he made everything so much fun with experiments and lab procedures. He really pushed me to work hard and do my best in science classes, that’s why I love science now.” This warrant clearly demonstrates how previous science experiences help develop student attitudes toward science and how the attitude of the teacher affected the development of the students’ attitude toward science. There was a positive impact because the student entered a science major in college.

The assertions and warrants are described in a narrative vignette in chapter four to examine how teacher feedback affects student attitudes toward science. The vignettes provide descriptions that express the experience for the readers to believe and trust. The descriptions accurately describe the behaviors and responses of the participants. The complete descriptions are included in chapter four.

Quantitative

Student Surveys

The student surveys were analyzed using measures of central tendency to identify the average responses for each survey item and by calculating the percentage of response for each survey item. The purpose of using these descriptive analyses was to simplify, summarize, and organize amounts of data and display the results through tables and charts (Mertler, 2009). StatCrunch (Pearson Education, 2009) was used to conduct the descriptive data analysis and create the tables and charts. The survey responses were tallied and entered into StatCrunch. Refer to Appendix E for the complete the breakdown of the survey responses by item and the
percent of individual responses by item. The scores are arranged from highest to lowest moving downward in the table.

A measure of central tendency used a single score to indicate what was typical or standard about the group of individuals. This procedure was used to describe the attitude level of the group of participants (Mertler, 2009). The mean was used to describe what the typical response of the participants was. A bar chart represents the overall mean of student responses in Figure 4.3 located in chapter four. The percentage of student responses for the survey items are displayed in Figure 4.1 and 4.2 located in chapter four. The survey accurately measured students’ current attitudes toward biology and described what the typical responses of the participants were.

Triangulation

The credibility of this study is supported through the process of triangulation; the use of multiple data sources and multiple data collection methods (Glesne, 1999; Mertler, 2009). Trustworthiness must be established by the researcher in order for the findings to be valid and reliable. Maxwell (2005) describes this as, “A strategy that reduces the risk that the conclusions will not reflect only the systematic biases or limitations of a specific source or method, and this allows the researcher to gain a broader and more secure understanding of the issues being investigated,” (p. 97). It is important to document all events that occurred during the investigation so that the reader believes there was no researcher manipulation on the data collection. The conclusions accurately reflect the participants’ perspective of how teacher feedback affects their attitudes toward science.

The data was collected in three different levels so that the results have more credibility and are believable by readers. Mertler (2009) explained, “Results collected from using various
forms of methods are supported by showing independent measures of the data that tend to agree with each other or at least do not directly contradict each other (p. 116). Thus the classroom observations reveal the same patterns or themes that were found by the surveys and by the interviews. The observations of student reactions to teacher feedback were confirmed as an accurate depiction of students in an introductory biology class because the student interviews and survey data also depict the same data results as the observations. The students were able to confirm reactions of students from specific feedback by elaborating in the interviews. The survey data was also confirmed through the interviews because the participants were asked to clarify and explain their chosen responses on the survey. The data collected was confirmed by individual participants that all discovered similar themes or patterns.

Another procedure to ensure the validity and reliability of the study was member checking. The purpose of this procedure is to share the data with the individual participant to ensure their ideas were represented correctly (Glesne, 1999). This was done with each individual who participated in the interview process. After the interviews were transcribed, the individuals were located in their biology class to check their own transcript for clarification. If there were any statements misunderstood by the researcher, the transcript was changed. This procedure also reduces the risk that the conclusions will not reflect any limitations or biases. Triangulation of using multiple data sources and method collection supports the qualitative results. Mertler (2009) explained that quantitative results are considered valid and reliable because various sources were used to examine the evidence that one source may not be able to collect. Each form of data collection was used to answer each research question.
Limitations

Qualitative Observations

Observations can be extremely useful in gathering actual data, but there are limitations with this type of collection method. One limitation is the risk of participants behaving and acting differently because they know they are being watched (Mertler, 2009). The mere presence of the researcher can alter the natural setting and create inaccurate data. To minimize this limitation, several classroom observations were conducted to eliminate the threat of unnatural behavior. The researcher sat at the back of the room and was not introduced to the class. This helped to remain neutral in the setting in hopes of retaining unnatural behavior from occurring.

Another limitation with classroom observations is the problematic method of field notes. Writing every situation or event that occurs can create problems with documenting the quotes and behaviors of the participants (Mertler, 2009). To minimize this limitation several observations were conducted at another field site prior to conducting this procedure. This helped to become familiar with important events that required notes and identifying events that were irrelevant in the field. The observation protocol also helped to keep the focus of the observations on feedback and student reactions.

Interviews

Interviews permit the researcher to probe further and ask for clarification in a participant’s response to a given question (Mertler, 2009). Although this is an accurate method to collect participant’s thoughts to specific questions, there are limitations as well. One such limitation is the fact that respondents can become uncomfortable in front of a tape recorder. To minimize this limitation, the participants were informed of the tape recorder before the interview
so that they would be expecting it. Also, the recorder was placed to the side of the table so the participant would not be looking at it while answering the questions. Another limitation with interviews is the fear participants may have about their responses. Some may fear that their responses may be used against them in the future. To minimize this limitation, the participants were provided a copy of their consent form before the interview that explained their responses will not be used against them. They were also informed that their name would be replaced with a pseudonym to conceal their identity.

Quantitative

Survey

Survey research can add strength to a study because they are the primary way to determine if an idea held or behaviors that were emitted are depictions of the general population (Maxwell, 1995). Along with the strength of survey research, there are limitations with this type of data collection. Sampling error is one limitation that is defined as the amount of error that can be expected between a sample statistic and the population parameter this statistic is used to estimate; the margin of error (Mertler, 2009). This means there are certain members of the population that are deliberately excluded through selection of the sample. This limitation can be minimized by increasing the sample size, which will decrease the sampling error (Cui, 2003). Thus an introductory biology class of 74 students was selected.

Non-coverage error is when the sampling frame does not cover some members of the population and they have no chance of being selected into the sample (Cui, 2003). This is a common limitation with mail surveys and was minimized by administering the surveys in person. All of the participants in the sample were provided a chance to complete the survey because it was in person and easy to return. The participants who were not interested in completing the
survey were allowed to leave. The non-response error is also common in statistical data because some members of the sample do not respond to all of the questions on the survey. Participants will chose to leave questions blank on surveys even if completed in person. They may not understand the questions or statements or they may not have had any knowledge or experience to answer the questions. To minimize this limitation, the participants were allowed to ask for clarification about the survey statements. The surveys also provided an option to be neutral or undecided if the statements did not relate to their experience.

The last limitation of survey research includes the measurement error. This error results from mistakes made by respondents when completing the surveys. Many participants will skip certain sections or inaccurately fill out an open-ended response (Cui, 2003). To avoid this limitation, the surveys did not require the students to skip any sections or provide an open-ended response. The surveys accurately measured current attitudes of students by asking questions about their current biology class. This was done to avoid participants answering about a previous science class and altering the results.

Summary

Chapter four reports the descriptive narrative of the classroom observations and student interviews. The classroom narrative describes the natural setting and how the participants reacted to teacher feedback within this setting. The interviews are also described in a narrative that illustrates each participant’s perspective on how teacher feedback affects their attitudes toward science. The survey results are included with bar charts that display the percentage of responses for the survey items and the overall average of student responses. Chapter five discusses the results and what future studies should investigate to help increase student retention rates in STEM disciplines.
CHAPTER 4: RESULTS

Introduction

The study investigated student attitudes toward science as a result of teacher feedback. Classroom observations were conducted to collect data about how students react to teacher feedback. Attitudinal surveys were administered to the students to analyze students’ current attitudes toward science, and individual interviews with students were completed to gather information about how teacher feedback affects students’ attitudes toward science. The data was analyzed through a coding scheme to find similar patterns and themes between the data. The codes were organized into assertions that support the research questions and supported with direct quotes from the participants. The following vignettes describe the events as they occurred and accurately portray the participants’ perspective.

Research Question 1: What are students’ reactions to teacher feedback?

Classroom Observations

The classroom observations took place in an introductory biology class of 74 students. Each morning the students would file into the classroom and find their assigned seats. The students did have assigned seats in alphabetical order, which wrapped around the odd, oval shaped room. There were three levels of seating in the classroom that would make one feel like they were sitting in a stadium. The students would find their seats, take out their notes, and sit patiently while briefly conversing to their neighbors.

Before the class, the instructor would be standing at the front of the room, preparing for his lecture. At each observation, at least one or two students would briefly talk with the instructor about previous events that occurred. The instructor began each class session by asking questions about the previous lecture or assignment. One such question was, “How did you do on the
homework that was due last night? Did you have problems?” (Field notes 2) A couple of students responded and the instructor went right into the lecture. This was the common routine most of the participants followed in all observation sessions.

Positive oral feedback increases student participation.

All six observations documented the instructor joyfully welcoming the students to the class. He would look through the crowd of eyes, smile, and cheerfully remark, “Good morning boys and girls, are you ready to think this morning?” Many students would nod their heads or shrug their shoulders with each greeting. One particular morning, a female responded, “Good morning Mr. Todd, how are you? What will we discuss today?” The instructor walked in front of her and kindly replied, “I’m doing well, thank you.” Each morning when the instructor greeted the students, at least one student responded. The instructor took time to get to know the students and established professional rapport with most of the class. Establishing a positive class climate increased student reactions.

Student reactions were also increased during the third observation when the instructor connected students to the content. Dr. Todd routinely began this individual lecture by asking about color of cats. The students sat in puzzlement and waited for the answer. Dr. Todd repeated his question, “Come on everyone, think about it. How do you think cats get their color? Why are tabby cats yellowish-orange, why are black cats black? I know you can come up with some ideas.” After a few minutes, Dr. Todd encouraged student reactions by exclaiming, “You’re all smart otherwise you wouldn’t be here. Make a guess!” It was after this statement when a female student shared her idea. “Is it because the male cat has certain genes that produce one color and the female cat has one pair of the same gene?” Dr. Todd took a minute to think about her response and replied, “You’re on the right track! But what genes cause the color in which cat?” The
female student was motivated to participate because the instructor provided positive feedback on performance.

A male student quickly exclaimed the correct answer after the female’s response and Dr. Todd turned abruptly to the student, “Yes! Bravo, that is why tabby cats are yellowish-orange and black cats are black! Good job everyone.” The students began to participate and provide answers after being motivated by positive feedback on their performance. Positive oral feedback found to increase student participation because the more positive comments that were provided to motivate, the more the students began to respond. This individual observation revealed similar reactions from students in the previous observations. The students were reluctant to participate until the instructor motivated them through feedback on their performance. The feedback was specific and positive, which increased student participation.

However, not all students were eager to participate until the instructor provided motivation through positive feedback. The fourth observation documented a still and silent class during the lecture. The instructor asked the class a question about gene pairs and the students sat frozen. Many stared at their table or looked around the room to avoid eye contact with the instructor. Dr. Todd explained, “I don’t care if your answer is wrong I just want to know what you’re thinking!” After this statement several female students raised their hand to volunteer to answer the question. Dr. Todd would also motivate students by exclaiming, “Kids, it’s ok to be wrong or not to know how to do this! That’s why I’m here, but you have to try. That’s the most important thing of being a scientist, you learn from your errors!” (Field notes 4) These observations show that students are not always certain of their ideas or answers but are willing to share when positive feedback is provided.
One morning, Dr. Todd wanted the class to practice writing gene pairs and asked for five students to write the problem from their homework on an overhead. All the students sat in silence and Dr. Todd looked around a room full of wide-eyed students caught in headlights. “Well, don’t raise your hands all at once, I only need five students.” (Field notes 5) Light laughter broke out through the dead air and a male student raised his hand to volunteer. “Wonderful, thank you. Whose next?” Again no students would volunteer. “Oh come on kids, it won’t hurt you. You did this in your homework last night! You can be wrong you know, I will help you through it.” It was after this reassuring statement that two females volunteered to write the gene pairs. “Thank you girls, I appreciate it,” Dr. Todd replied as he handed them the overhead sheets. The female students volunteered to participate after hearing they would be helped through the process. The specific feedback found to be motivating to the females because they put forth effort in class.

When it was time to check the work, Dr. Todd had the students explain their answer in front of the class. The male student explained his problem and Dr. Todd responded, “Great job. That is how you complete this problem. But for future reference, please do not use the letter “C”. It can be hard to distinguish between a little “c” and a big “C”. But you did a nice job here. Thank you, who’s next?” (Field notes 5) The female student shyly explained her problem to the class, in a low, soft voice. “Well, I like how you identified the dominant gene, but what happened to it when you went to the next column?” (Field notes 5) The female looked over her table and gasped, “Oh, you’re supposed to keep it because the woman from the story is the carrier! Oh I get it!” Dr. Todd raised his arms in the air and shouted with a smile, “Ah, the light bulb turns on! Good job, keep practicing these!” The female smiled in pride at her effort and walked back to her seat with her head held high.
These examples suggest that positive oral feedback from the instructor increases student participation. From the observations, it was clear that when the instructor provided various amounts of specific, constructive oral feedback to students, it increased the amount of student participation. The oral feedback from the descriptions above is considered to be positive because the comments provided students with information on how to improve their performance. The feedback was effective because it increased student participation. This documents that students are more likely to participate and improve their performance when the instructor encourages them with positive oral feedback. This type of feedback is very beneficial to students in introductory science classes because it clearly states what is expected from the students. When students understand the goals of how to be successful, they are more motivated to put forth effort (Poulos & Mahony, 2008).

However, as one might expect, there were times when the instructor provided positive oral feedback and did not receive any participation. The instructor asked students to name examples of vertebrate animals and no one provided any examples. Dr. Todd tried to spark student motivation by stating, “Come on kids, wake up! Think about the types of animals that are vertebrates. You can do this, this is easy stuff.” (Field notes 3) A few students shouted out some animals but they were not the kind of animals the instructor was looking for. “Yes those are vertebrates, but think about the species we discussed the other day. Name some of those animals.” (Field notes 3) The instructor was trying to encourage students to think about the animals they discussed in the previous lecture, but the students were not naming the correct examples.

Again, the class fell silent and the students continued to stare at Dr. Todd, waiting for him to give up and give examples himself. “Well, since you aren’t here to learn today I will not
teach. This will be your homework, write down examples from yesterday’s notes and create the gene pairs in tables. Come on, write it down! It’ll be worth 20 points and due tomorrow by 9 am,” (Field notes 3) Several students looked around the room in disbelief and began to complete the assignment. Even though there was a positive message, (you can do this), students were not willing to be wrong in this situation and the communication between the class and instructor began to brake down. In another similar example, the instructor provided time to review a homework assignment with the class before handing it in. “I will spend the first 10 minutes of class today to go over any problems you found difficult on the homework. Then we will hand it in.” (Field notes 2) The class mumbled in tired voices while slowly pulling out their homework. Many students scrambled to finish the problems while Dr. Todd waited for the class to settle.

Next he asked for problems to review and the class sat and stared without a word. “Come on, now’s your chance to make any corrections before I take it for a grade. There must have been problems that gave you difficulty, many of you e-mailed me questions regarding this assignment.” (Field notes 2) The students were lethargic and sat slumped in their seats in a daze. “Fine, hand in your homework. I don’t understand, if I was given an opportunity to make corrections on my work I would take it.” (Field notes 2) The instructor tried to motivate students to think and provide answers but they sat in their seats and did not put forth any effort to participate. The instructor took time out of his class to help improve student performance on an assignment that gave them difficulty, but the students did not respond. Positive oral feedback was provided to increase student participation but the students sat stiff in their seats.

*Negative oral feedback decreased student participation.*

The field observations also witnessed negative oral feedback and found that it decreased student engagement. During the lecture in the sixth observation, many students were engaged in
discussions and responding to questions asked by the instructor. The climate of the classroom was busy with lots of students thinking and talking about their ideas. A male student abruptly interrupted Dr. Todd asking, “Wait, Dr. Todd can you go back to the last slide?” In a state of confusion, Dr. Todd responded, “Why? We’ve already gone over that.” The class grew quiet and the climate immediately changed from a busy environment to a stand still. The same student responded with hesitation, “Well I didn’t see what it said. It’s not in our handout.” Dr. Todd went back to the previous slide and with a sigh added, “Well we’ve already gone over this, if you don’t know it by now you won’t know it for the exam.” Several students quickly wrote the notes on their handout and the instructor went on with the lecture. After this event, the class did not participate in discussions or asked questions. Many students sat in their seats waiting for the class to be over.

Another example of negative feedback followed the return of a quiz from the previous class. The beginning of this individual class started with the instructor expressing his disappointment in the turn of the grades. In the fourth field observation, Dr. Todd walked around the room with his head down. “Well, you must not know how to study because this was an easy quiz! We have gone over this stuff since the beginning of the class! Why aren’t you all putting in more effort?” The class sat in silence and stared at Dr. Todd. “Well, I guess it’s a good thing you are allowed to throw out the two lowest quiz grades. I’m sure no one will keep this quiz grade. Next time, do a better job of preparing.” The remainder of the class session was quiet and gloomy. Many students put their heads down on their desks while the instructor read through the lecture. There were no questions asked by students and no discussions held during this class session. When the class was over, every student darted out of their seats for the door.
These examples suggest that negative oral feedback can decrease student participation because the negative comments did not promote active participation or learning. The negative feedback caused student engagement and participation to decrease or stop altogether. The negative feedback occurred in response to student performance that did not meet the needs of the instructor. This type of feedback has been found to impact student motivation and attitudes toward the class because it does not motivate students to improve their performance (Cauley & McMillan, 2010). Instead the feedback decreases student motivation to be successful.

However, negative feedback did not always decrease student participation in the classroom. During the second class observation, Dr. Todd provided negative feedback on class work but this did not decrease student participation. The class was working on identifying genetic mutations in gene pairs when a male student was explaining his answer to one problem. Dr. Todd responds to his answer by stating, “Well, Thomas, you have the beginning of the gene correct but the mutation is all wrong. You need to remember who the carrier is and what chromosomes are present.” The student re-reads the problem and makes a correction. “That’s better. Thomas, you should know how to do this by now,” Dr. Todd stated in a disappointed tone. “I know, I misread the question. Let me try another one,” refuted the student, eager to prove his knowledge. The feedback was negative because the comment negatively referred to the performance of the student.

Summary

The descriptions of the classroom observations suggest that positive oral feedback increases student participation while negative oral feedback decreases student participation. Many students became engaged when the instructor motivated them through positive comments on their performance. The increased engagement occurred because the students felt confident in
their ability to be successful in the class because the instructor believed they were smart and capable of succeeding. Cauley and McMillan (2010) found students tend to value their instructors’ feedback when it concerns their academic performance. There were various times when the instructor provided constructive feedback to students about what to fix and several other students began to ask questions about their performance. Students feel more motivated and confident in challenging courses when they are provided with constructive feedback (Parker & Baughan, 2009). Therefore the more motivated students feel in a class, the more their attitudes will be positive because they feel confident that they can succeed.

The negative feedback from the instructor found to decrease student engagement. The students would stop responding to questions and stop participating in discussions because their academic performance was negatively impacted. Negative oral feedback has been shown to decrease student attitudes toward a particular class because the student no longer feels connected to the course or feels that he/she can be successful (Cauley, 2010; Iqbal, Azam, & Abiodullah, 2009; Thomas, 2009; Zachris, 2010). The instructor provided negative comments on student performance that left the students feeling disconnected to their class and lowered their confidence to succeed. Instructor feedback on student performance has been the main finding that impacts student attitudes toward science areas (Jensen & Moore, 2008; Rogers & Ford, 1997). Thus, because the negative comments decreased student engagement, it is suggested that the comments also deceased student attitudes.

However, there were moments when positive oral feedback was provided and it did not affect engagement, whereas negative oral feedback did affect engagement. The students were allowed to correct their homework before turning it in but there were no students who asked to go over any problems. The lack of engagement may be a result of student preference to feedback.
Some students may prefer written feedback on their work as opposed to listening to the corrections that need to be made. Therefore, the lack of engagement may be due to the preference of constructive feedback on student performance.

The moments when negative oral feedback was presented student engagement decreased. This suggests that negative oral feedback decreases student attitudes toward a particular class because the student no longer feels connected to the course or feels that he or she can be successful (Cauley, 2010; Iqbal, Azam, & Abiodullah, 2009; Thomas, 2009; Zachris, 2010). The negative comments referred to the students’ academic ability in the class and it left many students feeling insecure to be successful. Heritage (2007) found motivation from teachers influences students’ levels of self-efficacy. Therefore, the negative feedback was found to decrease student motivation, which also decreased their self-confidence and attitude toward the class. When students do not feel motivated by their teachers to be successful, they will stop putting forth effort to be successful and their attitudes will begin to decrease.

Overall, the findings from the classroom observations suggest that positive oral feedback can motivate students to work hard and be successful, which also increases their attitude toward the class. Negative oral feedback has found to decrease motivation in students to work hard because they no longer feel connected to their class. Andrade and Valtcheva (2009) speculate that teachers do not always have time to provide constructive feedback in the classroom, but student performance depends on motivation from feedback. Student attitudes tend to increase from motivation because they feel connected to their work. McInnes, James, & McNaught, (1995), Tinto (1997) and O’Neal and colleagues (2007) discovered students who felt they belonged to their major held a positive attitude felt that they could be successful. The positive
oral feedback helps students feel connected to their biology course and they will hold a positive attitude toward science and are likely to continue in the science disciplines.

Research Question 2: What are current attitudes of students towards science?

Student Surveys

The student surveys rated the feelings of 16 participants toward their current biology class. A 5-point Likert scale was used to score individual feelings and calculate the percentage of responses for each item. A frequency distribution table lists each survey statement and how many participants answered each response in Appendix D. A bar chart in Figure 4.1 displays the eight survey statements that are positive toward biology and the percent of student responses. Figure 4.2 displays a bar chart that shows the six survey items that are negative statements toward biology and the percent of student responses. The overall mean of student responses for the each survey item is displayed in Figure 4.3.

Overall, student attitudes toward biology are generally positive because the chart displays 62.5% (N=10) of students agreeing that they feel good toward biology. This is a significant finding because it relates to Moore and Jensen’s (2007) finding that students who encountered positive science experiences in high school are likely to hold a positive attitude toward science. There were also 37.5% (N=6) of students who felt secure and stimulated in their biology class and 31.25% (N=5) of students who felt a positive reaction to biology. However, only 12.5% (N=2) students strongly agreed to feeling at ease in biology while 37.5% (N=6) were unsure or disagreed. This difference may be a result of how students feel in their biology class as a result of teacher feedback. Refer to Figure 4.1 for the graphical representation.
There were 62.5% (N=10) of students who disagreed to feeling uncomfortable in biology and 56.25% (N=9) who also disagreed to disliking biology. This data also supports the claim that student attitudes toward science are generally positive. Although, there were 37.5% (N=6) of students who agreed to approaching biology with hesitation and only three students, 18.75%, disagreed. The numbers of responses to feeling uncomfortable toward biology are significant because it shows that the same number of students (N=10) who disagreed with this statement, agreed to feeling good toward biology. This suggests that students’ current attitudes toward science are positive. Refer to Figure 4.2 for the graphical representation.
On average, more students (M=4.78) disagreed in response to the survey items. There were some students who were not sure how they felt (M=4.35) toward biology and few agreed (M=4.14) to feeling positive toward biology. The survey was a mixture of positive and negative statements toward biology, with six negative statements and eight positive statements. The overall mean suggests that more students disagreed to the survey statements but they did not disagree to feeling good towards biology (62.5%). More students felt good toward biology and found biology to be interesting (43.7%) and fun (50%) than feeling uncomfortable, 62.5% disagreed. This suggests that students generally hold a positive attitude toward science because they enjoy biology and find it fun. Refer to Appendix A for the complete list and percentages of survey items and Figure 4.3 for the graphical representation of the average responses.
Summary

Overall, students currently hold a positive attitude toward science because 62.5% of students agreed to feeling good toward biology and 43.7% agreed that biology is interesting. Students who had positive science experiences in previous education tend to hold a positive attitude toward science (Moore & Jensen, 2007; Rogers & Ford, 1997). The findings suggest that these students experienced science in a positive manner because they have pursued a science major. It is clear that the students hold a positive attitude toward science because more than half of the students (N=16) disagreed to feeling uncomfortable and disliking biology, which would result in a positive attitude toward biology.

Moore and Jensen (2007) believed that students developed an attitude toward science based on their previous experiences in science classes. The survey suggests that students had
positive attitudes toward science because they entered a science major, and they currently still hold a positive attitude. According to George (2006), positive attitudes are developed from interests and enjoyment in science classes. The surveys also show this finding because 50% found biology to be fascinating and fun. These experiences help to develop positive attitudes toward science and can help recruit and retain students in the STEM disciplines.

However, there was evidence that students approached biology with hesitation and many were unsure or disagreed to feeling at ease or a positive reaction to biology. These survey items were expected to have the same results as feeling good and interested in biology because they were positive statements toward biology. The difference of the results may be due to the fact that this is the first or second science class the students have experienced at the college level. Their previous science experiences from high school may have been positive since they entered a science major, but they approached their biology class with hesitation because it is their first or second college level science class. The students may not have been academically prepared if they did not participate in a bridge program. Students who participated in STEM bridge programs felt prepared for their STEM courses in college (Bachman, Bischoff, Gallagher, Labroo, & Schaumloffel, 2008; National Science Teachers Association, 2009). This biology class is an introductory class for first and second year students, and the students may not yet feel secure in their science major.

The students did indicate that they enjoyed their biology class and this suggests that they currently hold a positive attitude toward science and their major. Their biology class must be a positive experience since 56.25% (N=9) of students did not agree to disliking their biology class. While the overall average of student responses was disagree (M=4.9), this does not represent a negative attitude toward science. Several of the survey statements were negatively worded;
meaning students disagreed with the negative feelings toward biology. Also, as previously stated, this is the first or second class for many students and they may still feel apprehensive toward their biology class due to a lack of college experience.

All in all, the surveys suggest that students currently hold a positive attitude toward science because they enjoy their biology class. Students who enjoy their science classes will likely hold a positive attitude toward science and continue on in science. Students who do not enjoy their science classes may develop a negative attitude and do not continue in a science major. College science instructors can help increase STEM retention rates by creating enjoyable science experiences in classes that will maintain or increase student attitudes toward science.

Research Question 3: How does teacher feedback affect student attitudes toward science?

Student Interviews

The individual interviews aimed to gather data about how teacher feedback affects student attitudes toward science and the data revealed several common themes from the participants’ responses. The themes include; students are motivated to do well in their science class because their science teacher motivates students through written and oral feedback, teacher feedback affects class attendance, and student attitudes are developed as a result of the attitude of the teacher and previous science experiences.

Student motivation to do well as a result of oral and written feedback.

Each participant took time out of their day to elaborate more about how feedback affects their attitude toward science. All five participants expressed that they felt motivated by their biology teacher to do well in the class because he would provide constructive feedback in class and on assignments and exams. Ruby explained, “My biology teacher will tell me good job or that my work is paying off, and it makes me feel good you know.” When she was asked if she
preferred verbal feedback or written feedback she answered, “Oh, I think I like when he writes comments on my labs and quizzes. That way I can go back and read the comments when I’m studying.” Ruby explained that she struggles in the biology class but when she reads the comments she feels motivated to work harder.

Seth also agreed that written feedback from the biology instructor motivated him to work hard in the class. “If I don’t do well on an exam, my biology instructor will write a comment like he thought I could have done better or I need to look over a certain section again because I confused a topic or something like that. So I go back to my notes and the book to make the correction on the exam. That way when I study he section again I’ll be studying the correct information.” He further explained that the comments would increase his attitude toward the class and he would find more time to study or schedule a meeting with the instructor to discuss topics of confusion.

Another male participant, Ken, had a similar response to feeling motivated by the written comments from the instructor. He did not prefer one form of feedback to the other because he did not pay much attention to the comments. He only looked for the mistakes he made on assignments and quizzes. He did however mention that he preferred to visit the instructor during office hours to discuss topics of confusion. “We talk about certain things in more detail, and I understand better after talking with the teacher.” Both Ken and Seth reported that they value the feedback from the instructor because it was constructive. The comments referred to how they can improve their academic performance in the class. This type of feedback has been found to be effective with increasing student motivation and attitudes because it helps improve student performance (Poulos & Mahony, 2008).
Even though Ken did not specifically state he had a preference of feedback, it can be inferred from his other comments that he preferred both forms of feedback. He looked for mistakes on assignments, which have to be marked by the instructor, and he would visit the instructor during office hours to discuss confusing topics. This is a form of oral feedback because they are discussing topics for clarification. Ken may not have specifically stated his feedback preference but it is clear that he values both forms. Sarah and Jessica did state that they preferred oral feedback because they like hearing the positive comments about their hard work. Huebner (2009) found females value oral feedback more than written feedback because they tend to have low self-confidence toward science areas. While this was found to be the case for Sarah and Jessica, Ruby, who had reported having low self-confidence, preferred written feedback. Overall, the participants expressed their motivation to do well in their introductory biology course is a result from the written and oral feedback from the instructor.

*Teacher feedback affects class attendance*

Almost all of the participants were quick to explain how feedback affects class attendance. Ruby immediately explained that she attends class on a regular basis because she would be afraid of missing a lot of information. She also added that she attends class to hear about how she is doing and what she needs to improve. “You can’t get that information from someone’s notes.” Ruby attends her biology class on a regular basis in order to receive oral feedback even though she previously mentioned that she prefers written feedback. This supports Huebner’s (2009) study that females do tend to value constructive oral feedback.

Sarah and Jessica believed that students who do not attend class on a regular basis may have worse grades than students who do attend class. Sarah explained her belief, “Well, our biology teacher always tells us how we can improve something on an assignment or what to
study for the next quiz. And the students who do not go to class will not know about this information, so they’re grades will not be as good.” The participants have mentioned that their biology instructor provides various forms of feedback to help improve student performance, and in order to receive the feedback the students attend class. Regular attendance in introductory science courses has found to increase student performance and this is the main factor for success in science areas (Moore, 2004; Moore, 2006; Moore & Jensen, 2008; Thomas & Higbee, 2000).

The instructor provided feedback of how to improve performance by setting goals for students to achieve. This type of feedback can be effective at increasing student attitudes toward science because the students know what is expected of them. This constructive feedback is the driving force for students to attend class and learn how to improve their performance to be successful.

However, not all participants believed attending class on a regular basis improves grades. Ken believed that a student’s grade is dependent on the work that they do, not on their attendance. “I don’t think attendance really makes or breaks your grade. Ultimately, the instructor gives you a grade for your work, not to see your face everyday. There are students who come and sleep the whole time, why should those students still pass just because they show up. They clearly do not make an effort to learn.” Ken was then asked if he attends his biology class on a regular basis, “Well no. We are allowed to miss a few classes without it hurting our final grade, so I tend not to show up everyday. But I only miss if I understand the topic being covered. I don’t want to waste the teachers’ time if I already understand it.” Then he was asked if he noticed a difference in his grades on quizzes or homework for not attending regularly. He responded, “Oh I don’t know, I don’t think there’s a difference. But if I get something wrong that
I knew I understood I go to office hours to talk about it.” This is an example where teacher feedback did not affect a student’s attendance.

Taken as a whole, teacher feedback from the biology teacher does affect most of the participants’ class attendance. Four of the five participants reported regularly attending class in order to receive feedback on their academic performance. The students found the feedback valuable and effective at improving their performance. The instructor promoted regular class attendance by providing constructive feedback in the classroom. In order for students to improve they must come to class. College instructors believe that academic success depends largely upon students’ levels of academic engagement (Jensen & Moore, 2008) which students also believe is associated with attending classes (Moore, 2004). The higher the grade the student receives in an introductory science course, the more their self-confidence will increase and promote a positive attitude toward science (Rogers & Ford, 1997).

Student attitudes develop as a result of teacher attitude and previous science experiences.

This was an interesting theme that emerged from all five participants. Previous science experiences are usually where students develop their attitude toward science (Moore & Jensen, 2007), but student attitudes were also found to develop according to the attitude of the science teacher. Sarah passionately described her science experiences in elementary and middle school as fun, exciting, and interesting because of all the hands-on experiments and projects. She further described her AP Biology teacher in high school as the one who motivated her to pursue a science career. “My high school AP Biology teacher really motivated me to look into science as a career. He was really funny and easy to talk to; he made everything so much fun with experiments and lab procedures. He really pushed me to work hard and do my best in science classes, that’s why I love science now.” Sarah also had positive experiences in science during
her elementary, middle, and high school education, which caused her to develop a positive attitude toward science and enter a science major.

On the other hand, Jessica experienced positive science experiences in elementary but negative experiences in high school because of her teachers’ attitude. “Well in elementary my teachers were really energetic about science and allowed us to explore and ask questions. I’m one who wants to know why something works or why something does this or that. So I asked a lot of questions and my teachers loved that! And ever since I really liked science... Then in high school I started asking questions but my chemistry teacher told me to stop asking why and just accept the facts. I decided to go onto science in college anyways because I wanted to understand why.” Jessica’s attitude toward science was not affected by her high school teachers’ attitude or comment that she should not inquire clarification.

When she was asked if her biology teacher motivates her to ask why and to do well she responded, “Oh yea, I really like my biology class because the instructor actually explains things. Plus he will take time to talk about topics and answer my questions. He always tells me I am doing a good job.” This finding suggests that Jessica’s attitude toward science is positive because the attitude of her current biology teacher motivates her to ask questions and do well in the class. Her previous science experiences in elementary may have motivated her to enter a science major in college to find answers to her questions since she did not receive answers in high school. Now that her science teachers’ attitude is positive toward her inquiry, she holds a positive attitude toward science.

Ruby experienced science in a different way, by developing a positive attitude toward science from her high school science teacher and not the previous experiences. Ruby discussed her fascination with science and that she was interested in science, but did not find the work to
be as invigorating. “I struggled in my science classes in high school and always had to go for help. I liked learning about it but it took me a while to memorize and understand facts and reasons.” The negative experiences did not deter Ruby however, because she went to her science teacher for help, she developed a positive attitude and entered a science major in college. “My teachers really motivated me in high school to stick with science as a major. I struggle from time to time in science and sometimes I feel like I should try something different, but my high school science teacher helped me with assignments and made me believe I could do this.” Ruby’s high school science teacher held a positive attitude that she could be successful in science and found ways to motivate her to stick with it.

Ruby was then asked if her biology teacher motivates her to do well and she replied, “My biology teacher is always willing to help me. I go for help about once a week and he talks to me about how to improve my work. I feel like he wants me to succeed.” The attitude of her current science teacher is positive because he also finds ways to motivate Ruby to improve her performance. The data suggests that students develop their attitudes toward science as a result of previous science experiences and the attitude of their teachers.

Ken, though, did not experience positive science experiences or positive teacher attitudes and still enrolled in a science major. “I took science classes in high school and was really bored. The teachers weren’t very nice and only taught what they thought we should know. There were some lab experiments but they were boring. I went into a science major because I was good at science. I like that its objective, a right or wrong is always found.” The science teachers held a negative attitude because they were not concerned with Ken’s performance. Ken also reported not enjoying his science classes in high school because they were boring. Usually students who experience negative science experiences will not enter a science major in college (Moore &
Jensen, 2007), but Ken did. This suggests that Kent held high self-confidence of his academic abilities in science and decided to enter a science major because he felt he was good at it. The data suggests his current attitude toward science is positive because, “I enjoy my science class now more than my classes in high school. The work is harder and more challenging and I like that. Plus my teacher will talk to me about different topics and gives me advice on how to fix my work to do better.”

Summary

On the whole, teacher feedback was found to increase student motivation and increase student attendance, while student attitudes toward science develop as a result of teacher attitudes. The participants explained that they felt motivated to do well in their introductory biology course because of the constructive forms of feedback from their instructor. The biology teacher provided written and oral forms of feedback, which motivated students to work hard. Poulos & Mahony (2008) determined that first and second year students prefer constructive oral feedback from their instructors because college courses are drastically different from high school. Several participants stated they preferred oral feedback because it made them feel good to hear the positive comments on their work. The evidence suggests that because students felt good about their work, their attitudes were positive toward their class.

The male participants expressed their preference of oral and written forms of feedback, which was the same preference as the female participants. One of the male participants stated he did not have a preference but that he looks for corrections on his work. This suggests that he prefers written feedback because he looks for comments on what needs to be corrected. This is constructive feedback because the comments are specific to the individual on how to improve academic performance (Poulos & Mahony, 2008). Several female participants reported
preferring oral feedback because it makes them feel good to hear. Huebner (2009) also found that females prefer oral feedback because it increases their self-confidence of being successful in a challenging class. There are about the same number of female students enrolled in a STEM major as male students, and providing positive oral feedback in the classroom can increase student attitudes toward science and help retain students in science disciplines (Osborne, Simon, & Collins, 2003).

The positive oral feedback also found to increase class attendance. One of the female participants explained that she attended class on a regular basis because she wanted to receive the constructive oral feedback and because she enjoyed the class and the instructor. Moore (2004) found that students tend to skip classes more in college than in high school because attendance is mandatory in high school and optional at the college level. Attendance was not stated as mandatory but students were allowed to miss a specific number of classes without affecting their final grade.

Most of the participants explained they attended class on a regular basis, even though attendance was not mandatory, because they enjoyed listening to the stories from the instructor. Forming a professional relationship between students and the instructor helps motivate students to be successful because they feel connected to their major (McInnes, James, & McNaught, 1995; O’Neal, Wright, Cook, Perorazio, & Purkiss, 2007; Tinto, 1997). The instructor attempted to form a professional relationship with the students by relating real world situations to the content, which seemed to create a connection from the class to the students. The instructor was also available outside of the classroom to provide extra help and support for students, and this was mentioned as a motivating factor for several participants. McInnes et al. (1995) found help sessions, where the instructor provides additional help outside of the classroom, to be successful
at motivating students to improve their academic performance. The office hours that were provided by the biology instructor was stated as helpful in improving the participants’ academic performances because they were provided additional constructive feedback.

Student attitudes were developed according to students’ previous science experiences and by the attitude of their teachers. The attitude of the teacher toward science is passed to the student through different types of feedback on the students’ learning abilities (Cantrell, Young, & Moore, 2003). The participants reported enjoying their science experiences in elementary but their attitudes began to change during middle and high school. Jarvis and Pell (2002) also discovered that interest and enthusiasm toward science decreases with age as students enter middle and high school. The attitudes of the participants were positive because they enjoyed their science experiences as well as their current science class. Although, one participant explained he did not enjoy his high school science classes or teachers because they did not care about his performance, but he still entered a science major because he maintained a strong interest in science.

Student attitudes toward science have shown to be influenced by teacher attitudes and the experience of their science classes. All of the participants enjoyed their introductory biology class because the instructor made the effort to establish a bond between the students and the class. Class attendance, participation, and motivation were found to increase as a result of the teacher relationship and positive feedback that was provided. Therefore, student attitudes increased or were maintained at a positive level toward science because they felt connected to their science class and they felt support from their teacher to be successful. One participant even mentioned she attended class in order to receive feedback on her class performance. This
evidence demonstrates that student attitudes toward science are affected as a result of teacher feedback.

In general, teacher feedback increased class attendance because the students felt connected to their instructor and their class. The participants reported that they wanted to hear stories and receive feedback from their instructor and this caused them to attend class on a regular basis. College instructors believe that academic success depends largely upon students’ levels of academic engagement (Jensen & Moore, 2008) which students also believe is associated with attending classes (Moore, 2004). The instructor kept the students interested and engaged in the class through stories that related the content to the students. Students attend class because they believe they will be successful, and teachers encourage students to attend classes by relating the class to the students to make them feel connected. This can help increase retention rates in STEM disciplines.
CHAPTER 5: CONCLUSIONS

Summary of Study

The purpose of this study was to investigate student attitudes toward science as a result of teacher feedback. There were three research questions that include; what are student reactions to teacher feedback, what are students’ current attitudes toward science, and how does teacher feedback affect student attitudes? Three different forms of data collection were used; classroom observations, student surveys, and student interviews. Student attitudes are a major factor of deciding to enter a STEM discipline and to remain in the major. Students who have a positive feeling toward science are more likely to remain in science majors than students who have a negative attitude toward science. This chapter discusses the findings and implications that were found from the investigation.

Discussion of Findings

The findings suggest students who enter a science discipline hold a positive attitude. Teachers who are positive toward science create meaningful connections from the content to the student and provide positive feedback to increase student performance. Students who feel connected to their work will likely hold a positive attitude and continue on with their major. Student participation was found to increase as a result of positive oral feedback and student attendance also increased as a result of establishing a professional teacher relationship and providing positive feedback. Student attitudes increase when they are motivated to succeed by their teachers and this can help increase retention rates in STEM disciplines.

Providing hands-on experiences at the primary level can help students become comfortable with their teachers and with their abilities to succeed in science (McInnes, James, & McNaught, 1995; O’Neal, Wright, Cook, Perorazio, & Purkiss, 2007; Tinto, 1997). Jarvis and
Pell (2002) noted that interest and enthusiasm toward science decreases with age as students enter middle and high school. The participants mentioned how their attitude did in fact decrease during these years. It is important to engage students in science activities in the primary years in order for children to feel comfortable in science. The surveys showed participants felt comfortable toward science and the interviews revealed that they were excited to attend class because they had developed a positive relationship with their teacher.

Huebner (2009) found constructive feedback can increase student motivation to be successful and the data collect suggests the same. The participants in the observations participated more when they were supported through feedback and the interviews explained student attitudes toward science will increase when their teacher holds a positive attitude as well. First and second year students need various amounts of feedback in order to remain interested and motivated to continue in a STEM discipline.

The findings are important because they can help increase retention rates of future STEM students. More students will enter a STEM discipline if they know they will be supported and motivated to perform their best. Attendance of introductory science classes will increase when students enjoy attending classes because of the professional relationship with the teacher and the positive feedback. Teachers who make the content connect to the students’ lives will also notice an increase in student attendance and participation. The more interested students are in science, the more likely they are to remain in that major.

Educators in K-12 grades can benefit from this study by maintaining a positive attitude toward science and providing students authentic, hands-on experiences in science classes. Students perform better when they understand the meaning of science experiments and how their hard work can benefit others. Educators can also encourage students to pursue a STEM career by
getting students involved in science activities outside of the classroom. Applying students’
interest of science to real world situations can help keep students interested in science and
courage them to enter a STEM degree.

Finally, the findings from the study can benefit me as a future elementary teacher. My
previous science experiences were negative and I do not want to pass this attitude to my future
students. Research has found that students in primary grades will develop a similar attitude
toward science based on the attitude of the teacher. I want to create positive attitudes towards
science and apply real world situations into science lessons and motivate students with positive
feedback to work hard and be successful. This study can help me create positive attitudes toward
science and help increase retention rates of future STEM students.

The investigation of student attitudes toward science has taught me, a future elementary
science teacher, it is important to hold a positive attitude toward science. Teaching science
should be fun and hands-on, with activities that relate real world situations to science content.
Teacher attitudes have a large influence on student attitudes, especially in the primary grades. As
an elementary science teacher, I have learned how to motivate and support students to be
successful through constructive feedback. Students need to hear positive feedback about their
performance so they can feel confident. The findings have shown me how negative feedback can
change students’ attitudes and self-confidence towards science. I plan to engage future students
in science activities, provide constructive feedback to improve academic performance, and create
positive attitudes toward science in hopes of increasing STEM retention rates.

Implications

Future research on the retention rates of STEM disciplines should investigate the type of
feedback being provided at the high school level. This will provide information on how high
school science teachers are motivating and encouraging students to enroll in STEM disciplines after high school. This can ultimately increase STEM enrollment rates in colleges and universities by finding evidence of best ways of supporting students and increasing positive attitudes toward STEM disciplines. Classroom observations would collect valuable information from high school science teachers.

The interviews and the survey results found that students had a mixture of positive and negative science experiences in high school, which played a crucial role in deciding to enter a science major. Bachman and colleagues (2008) found students who participated in bridge programs after high school were more likely to enter a STEM major in college and held a positive attitude toward these majors. Future studies should investigate how high school science teachers are preparing students for STEM majors in college and how they’re motivating students to pursue a STEM degree.

In conclusion, future research is needed to find solutions to increase retention rates of students in STEM disciplines. Constructive oral and written feedback was found to increase student motivation in an introductory biology class, which also increased student attitudes toward science. More research is needed to investigate how feedback can affect student attitudes at the high school level and how students are prepared for STEM disciplines.
Reference List


McInnes, C., James, R., & McNaught, C. (1995). *First Year on Campus: Diversity in the initial experiences of Australian undergraduates*. Canberra AGPS.


National Science Teachers Association (2009). Crossing the bridge to STEM success. *NSTA*


Appendices

A

Thesis Observation Protocol
Date:
Time:
Classroom Atmosphere:
Observer:

<table>
<thead>
<tr>
<th>Feedback Comments from Instructor</th>
<th>Student Reaction/Response from instructor comments</th>
<th>Important moments in lecture</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Undergraduate Science Student Interview Questions

1. Describe your current grade year and major.
2. Why did you decide to pursue this major?
3. Why did you decide to take a biology course?
4. Why do you enjoy/not enjoy biology?
5. Describe what your science experiences were like in elementary, middle, and high school.
6. Do you feel motivated to work hard in your biology class? Why or why not?
7. How important is it to you that you receive frequent feedback from your biology teachers? Why is this important to you?
8. What kinds of feedback do you find most helpful; oral, written, positive, or negative? Why are these helpful to you?
9. Do you like when your biology teacher provides constructive feedback on your performance? Why or why not?
10. Why do you believe students are leaving the science disciplines before they graduate?
11. What would you change about science courses and why?
The Biology Attitude Scale

**Likert-type scale**

Each of the statements below expresses a feeling toward biology. Please rate each statement on the extent to which you agree. For each, you may:

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>strongly agree</td>
<td>agree</td>
<td>be undecided</td>
<td>disagree</td>
<td>strongly disagree</td>
</tr>
</tbody>
</table>

1. Biology is very interesting to me.
2. I don’t like biology, and it scares me to have to take it.
3. I am always under a terrible strain in a biology class.
4. Biology is fascinating and fun.
5. Biology makes me feel secure, and at the same time is stimulating.
6. Biology makes me feel uncomfortable, restless, irritable, and impatient.
7. In general, I have a good feeling toward biology.
8. When I hear the world “biology,” I have a feeling of dislike.
9. I approach biology with a feeling of hesitation.
10. I really like biology.
11. I have always enjoyed studying biology in school.
12. It makes me nervous to even think about doing a biology experiment.
13. I feel at ease in biology and like it very much.
14. I feel a definite positive reaction to biology; it’s enjoyable.
### Table 4.1 Frequency of Student Responses Per Survey Item

<table>
<thead>
<tr>
<th>Survey Item</th>
<th>SA f (%)</th>
<th>A f (%)</th>
<th>U f (%)</th>
<th>D f (%)</th>
<th>SD f (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biology is very interesting to me</td>
<td>4 (25%)</td>
<td>7 (43.75%)</td>
<td>4 (25%)</td>
<td>1 (6.25%)</td>
<td>0</td>
</tr>
<tr>
<td>I don't like biology, and it scares me to have to take it</td>
<td>0</td>
<td>3 (18.75%)</td>
<td>3 (18.75%)</td>
<td>5 (31.25%)</td>
<td>5 (31.25%)</td>
</tr>
<tr>
<td>I am always under terrible strain in a biology class</td>
<td>1 (6.25%)</td>
<td>0</td>
<td>5 (31.25%)</td>
<td>7 (43.75%)</td>
<td>3 (18.75%)</td>
</tr>
<tr>
<td>Biology is fascinating and fun</td>
<td>2 (12.5%)</td>
<td>8 (50%)</td>
<td>5 (31.25%)</td>
<td>1 (6.25%)</td>
<td>0</td>
</tr>
<tr>
<td>Biology makes me feel secure and stimulating</td>
<td>0</td>
<td>6 (37.5%)</td>
<td>6 (37.5%)</td>
<td>4 (25%)</td>
<td>0</td>
</tr>
<tr>
<td>Biology makes me feel uncomfortable</td>
<td>1 (6.25%)</td>
<td>1 (6.25%)</td>
<td>1(6.25%)</td>
<td>10 (62.5%)</td>
<td>3 (18.75%)</td>
</tr>
<tr>
<td>In general, I have a good feeling toward biology</td>
<td>2 (12.5%)</td>
<td>10 (62.5%)</td>
<td>4 (25%)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>When I hear the word &quot;biology&quot; I have a feeling of dislike</td>
<td>0</td>
<td>1 (6.25%)</td>
<td>3 (18.75%)</td>
<td>9 (56.25%)</td>
<td>3 (18.75%)</td>
</tr>
<tr>
<td>I approach biology with a feeling of hesitation</td>
<td>0</td>
<td>6 (37.5%)</td>
<td>4 (25%)</td>
<td>3 (18.75%)</td>
<td>3 (18.75%)</td>
</tr>
<tr>
<td>I really like biology</td>
<td>2 (12.5%)</td>
<td>5 (31.25%)</td>
<td>6 (37.5%)</td>
<td>3 (18.75%)</td>
<td>0</td>
</tr>
<tr>
<td>I have always enjoyed studying biology in school</td>
<td>1 (6.25%)</td>
<td>5 (31.25%)</td>
<td>4 (25%)</td>
<td>5 (31.25%)</td>
<td>3 (18.75%)</td>
</tr>
<tr>
<td>It makes me nervous to even think about doing a biology experiment</td>
<td>0</td>
<td>0</td>
<td>3 (18.75%)</td>
<td>10 (62.5%)</td>
<td>3 (18.75%)</td>
</tr>
<tr>
<td>I feel at ease in biology and like it very much</td>
<td>2 (12.5%)</td>
<td>1 (6.25%)</td>
<td>6 (37.5%)</td>
<td>6 (37.5%)</td>
<td>1 (6.25%)</td>
</tr>
<tr>
<td>I feel a definite positive reaction to biology; enjoyable</td>
<td>1 (6.25%)</td>
<td>5 (31.25%)</td>
<td>5 (31.25%)</td>
<td>5 (31.25%)</td>
<td>0</td>
</tr>
</tbody>
</table>