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Student Perception of Relevance of Biology Content to Everyday Life: A Study in Higher Education Biology Courses

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STUDENT PERCEPTION OF RELEVANCE OF BIOLOGY CONTENT TO EVERYDAY LIFE: A STUDY IN HIGHER EDUCATION BIOLOGY COURSES

by

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Abstract

The purpose of this mixed method case study was to examine the effects of methods of instruction on students' perception of relevance in higher education non-biology majors' courses. Nearly ninety percent of all students in a liberal arts college are required to take a general biology course. It is proposed that for many of those students, this is the last science course they will take for life. General biology courses are suspected of discouraging student interest in biology with large enrollment, didactic instruction, covering a huge amount of content in one semester, and are charged with promoting student disengagement with biology by the end of the course. Previous research has been aimed at increasing student motivation and interest in biology as measured by surveys and test results. Various methods of instruction have been tested and show evidence of improved learning gains. This study focused on students' perception of relevance of biology content to everyday life and the methods of instruction that increase it. A quantitative survey was administered to assess perception of relevance pre and post instruction over three topics typically taught in a general biology course. A second quantitative survey of student experiences during instruction was administered to identify methods of instruction used in the course lecture and lab. While perception of relevance dropped in the study, qualitative focus groups provided insight into the surprising results by identifying topics that are more relevant than the ones chosen for the study, conveying the affects of the instructor's personal and instructional skills on student engagement, explanation of how active engagement during instruction promotes understanding of relevance, the roll of laboratory in promoting students' understanding of relevance as well as identifying external factors that affect student engagement. The study also

investigated the extent to which gender affected changes in students' perception of relevance. The results of this study will inform instructors' pedagogical and logistical choices in the design and implementation of higher education biology courses for non-biology majors. Recommendations for future research will include refining the study to train instructors in methods of instruction that promote student engagement as well as to identify biology topics that are more relevant to students enrolled in non-major biology courses.

Dedication

To my children, Noah, Naomi, Emma, and Jonah, I'll love you forever…; and to my parents, Virgil and Elizabeth Himschoot who have taught me the timeless message of unconditional love. They have shown me how - and given me reason to love…no matter what.

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CHAPTER 1. INTRODUCTION

Introduction to the Problem

The majority of students entering higher education declare majors other than biology. According to the U.S. Department of Education Institute of Education Sciences, National Center for Education Statistics (2010), of the 1,563,000 bachelor's degrees conferred in 2007–08, the health sciences numbered at 111,000 with the fields of business, social sciences and history, and education accounting for the majority of degrees conferred. As stated in the Bureau of Labor Statistics, Career Guide to Industries, 2010-11 Edition (2010) and based on the current United States population of those employed over the age of sixteen, (U.S. Census Bureau, 2008), the number of individuals in science related professions totals nearly ten percent. As a part of higher education general education requirements for degrees other than biology, students (*non-biology* majors) are typically required to take at least one semester of biology. It is the nature of liberal arts programs to have a course that is known as general biology that is not as rigorous (Francom, Bybee, Wolfersberger, Merrill, 2009) as the biology course for non-majors. Recent research indicates that this may be the last biology course ever taken by the remaining ninety percent of the population (Marcus, 1993).

To improve the quality of general biology course instruction with increased measureable learning evidenced in student interest and test scores, researchers have explored many ways of increasing student interest and engagement. Yet, with the explosion of science knowledge, instructors feel the need to present more information which leaves less time for integration and problem solving (Chaplin & Manske, 2005).

Consequently, introductory level biology classes are reduced to classic memorizing and recalling experiences (Lord & Baviska, 2007).

Large enrollments predominate introductory courses at most universities (Allen & Tanner, 2005). According to Allen and Tanner (2005) typical higher education general education biology courses involving large numbers of students are taught in a large lecture hall meeting two to three times per week, with smaller groups meeting in a lab setting for two or more hours per week for experiences in exploring and discovering biological concepts and phenomena (Oliver, 2007; Varma-Nelson, 2006). Large class lectures are often remiss in motivating students to participate in meaningful intellectual engagement (Smith, Sheppard, Johnson, & Johnson, 2005). Historically, large classes are not an easy environment in which to stimulate the intellectual processes typical of higher education for students (Seymour & Hewitt, 1977) or for instructors (Carbone & Greenberg, 1998).

The number of students choosing to enter the fields of science, math and engineering is on the decline (Sorensen, 2000; Kidman, 2008), while gender differences have begun to show a change in the populations choosing to enter science related fields. Historically, few women entered science fields 50 years ago. Gilligan's (1982) work on identifying the female voice, independent of context sparked interest in determining the role of gender in career choices, especially the sciences. In the technology rich information age of the past several decades, the number of women entering science fields is changing. While in the last 20 years, programs targeting women involvement in science, technology, engineering, and mathematics (STEM) careers have been on the rise

(Fuselier & Jackson, 2010) resulting in increased numbers of women with doctorates in some STEM fields, the increase in female faculty has not been proportional. Although women are no longer prevented from entering science fields and working in scientific laboratories, "other forms of gender discrimination persist" (Rosser, 2004, p. 263). What is referred to as "the leaking science pipeline" (Blickenstaff, 2005; Adamuti-Trache & Andres, 2008) illustrates the progression of women's attrition in the field of science and careers, starting with high school (Cleaves, 2005). The impact of gender bias and its role in career choice demonstrates the need to include gender bias in this study.

In the academic environment the variables at work in changing enrollment also bear out that introductory science courses are given credit for discouraging science majors with the initial intention and ability in science, to switch to non-science fields and traditionally tougher courses have been used to weed out weaker students (Sorensen, 2000). This is clearly not the best course of action for an essential biology course that teaches the majority of students' critical information necessary for life, at this final juncture of their academic career.

As a result, models of instructional design have been developed to improve student interest, increase measurable learning, and to alter didactic instruction, otherwise known as lecture, in biology courses in higher education (Lord, 1998; Udovic, Morris, Dickman, Postlethwait, & Wetherwax, 2002). Various instructional strategies such as cooperative learning (Slavin, 1995), active learning teaching strategies (Freeman et al., 2007), problem-based learning (Waterman, 1998), and inquiry-based learning (Udovic et al., 2002) play a role in fostering student interest. According to Osborne, Simon, and

Collins (2003), students' attitudes about science as well as students' perception of relevance also play a significant role in determining student interest (Osborne, Simon & Collins, 2003).

Studies of student attitudes have been carried on for the last 50 years (Osborne, Driver, & Simon, 1996; Knight & Wood, 2005; Taba, 1962). According to Osborne, Driver & Simon (2003), promoting positive attitudes towards science, scientists, and learning science, which has always been a component of science education, continues to grow as a matter of concern. Preparing communities, schools, and students for the demands of an information rich society where information is growing exponentially is the heart of the educational process (Marx, 2006). Marx (2006) proposes 16 trends that will profoundly affect education and the whole of society in the 21st century. Marx's (2006) trends contain three issues that spotlight the significance of effective science instruction. Marx (2006) has observed that technology will increase the speed at which information, including scientific discovery, will be communicated. Standards and high stake tests will fuel a demand for personalization in an educational system increasingly committed to lifelong human development and learning. And scientific discoveries and societal realities will force widespread ethical choices. The explosion of information, and the need for individuals to become and remain life-long learners equipped to make ethical choices are key reasons to focus on finding effective methods of instruction. Effective biology instruction is pivotal in the preparation of students today to be effective life-long contributors to society (Osborne, Driver, & Simon, 1998), the ultimate goal of science education as outlined by the National Science Education Standards (National Research Council, 1996).

In Osborne et al.'s (2003) research on student views of science, interest in biological science and interest in physical science was a matter of perception of relevance, where students perceived biology to be relevant, the relevance of physical science was more difficult for them to identify. Courses that lack experiences in application of the course content and concepts are rated poorly by students who failed to see the need to learn information that is disconnected from their lives. Hohman, Adams, Taggart, Heinrichs, and Hickman (2006), advocate that students must learn to make connections among the sciences. Connections between the sciences help students connect science to their personal world (Allen & Tanner, 2005). Engaging with the content is essential for the creation of individuals who are prepared for the demands of a rapidly changing information rich culture (Hohman, Adams, Taggart, Heinrich, & Hickman, 2006).

Though students' perception of relevance are pivotal to meaningful learning of science and the ability to make connections between the sciences (Hohman, Adams, Taggart, Heinrich, & Hickman, 2006), little is known about the effect that the instructional methods implemented in university level non-major biology courses have on students' attitudes toward biology, specifically perceptions of relevance of biology content to everyday life. This mixed method study in the form of a case study will focus on identifying instructional methods used in higher education biology courses and their effect on students' perception of relevance of biology to everyday life.

Background of the Study

Many entry level non-major biology courses are credited with driving off students interested in biology (Felder & Brent, 2006). Over the last 50 years, methods of instruction have changed in general biology lectures and labs for non-majors (Osborne et al., 2003). Though some instructors retain traditional didactic lecturing as the norm, many new techniques employ interactive instruction and activities that draw students into active engagement in the learning process. Because students learn by constructing new concepts built on previous perceptions, those involved in learning experiences founded in an understanding of the tenets of constructivism are provided opportunities for the scaffolding of thinking and actions with new and old knowledge (Jonassen & Land, 2000). Cognitive psychologists have long known that students learn more by doing something active rather than in traditional passive ways (McKeachie, 2002). This is further corroborated by the premise that physical experiences are one way in which individuals make sense of the world (Von Glasersfeld Glasersfeld, 1987).

Initiatives that allow students to work with other students include active learning teaching strategies (Freeman, 2007), peer-led team learning (Brainard, 2007), problem-based learning (Sungur, Tekkaya, & Geban, 2006), the use of case studies (Waterman, 1998) and laboratory courses (Cavanagh, 2007). Within an understanding of Vygotsky's social constructivist perspective, strategies have been designed to accommodate the social learning needs of students in higher education institutions (Lord, 1998). Current methods of instruction address student interest and willingness to become engaged in biology courses by using activities where students work together to achieve common goals. According to Jonassen & Land (2000), learning by doing is a form of social constructivism. Though the constructivist viewpoint is pre-eminent in science instruction, opinions range regarding the manner in which the process of knowledge construction occurs (Palmer, 2005). Bandura's (1977) research on learning is based on the premise that most human behavior is learned observationally through modeling. By observing others, students form an idea of how new behaviors are performed. The new information serves as a guide for new behaviors. This has given the implementation of constructivist based course design validity in the process of attempting to retain student interest in higher education biology courses.

Historically, evaluation of methods of instruction has been in the form of measurable learning outcomes and interest in the course (Freeman, 2007). Based on Osborne et al.'s (2003) research, perception of relevance of content is pivotal to the increased meaningful learning and student interest. Courses lacking application of the content to their lives are rated poorly by students who fail to see the connection between content and the need to know it. Students showing little interest in higher education biology courses fail to see the relevance of the content to their lives (Hohman et al., 2006). Though student perception of relevance is critical for students' learning, little is known about how current models of instruction are affecting students' perception of relevance.

Statement of the Problem

While students' perception of relevance is critical for meaningful learning (Osborne et al., 2003) little is known about the effectiveness of different methods of instruction used in higher education non-major biology courses on male and female students' perceptions of relevance of biology content to everyday life. A solid foundation in biology content is a critical component of instruction for higher education. Most students enrolled in higher education are non-biology majors, yet need the biology knowledge that will carry them into the future equipped to make sound decisions about themselves, the environment, and society. The National Science Education Standards (NSES) goal is to equip all learners with the skills and knowledge to become and remain life-long learners contributing positively to society. Many models of instructional design have been developed to improve student interest and measurable learning in biology courses in higher education (Lord, 1998; Udovic et al., 2002). Many studies have explored the key variables that increase student engagement and interest, but none have addressed by gender, changes in perception of relevance after participating in a non-majors biology course. Nor have any addressed how student experiences with various methods of instruction affect perception of relevance of biology content to everyday life.

Purpose of the Study

The purpose of this mixed method study was to explore how and to what extent student experiences in higher education non-major biology courses affect perception of relevance of biology content to everyday life. Student perceptions of relevance were quantified by administering a Perception of Relevance Survey pre and post instruction in three topics in the general biology course. At the end of instruction, students also took a Student Experience Survey by answering questions about various behaviors of the professor and activities students were asked to participate in during the course that are specific to methods of instruction. These data were correlated to determine if a relationship between changes in perception of relevance scores and identified methods of instruction existed.

By interviewing students about their experiences in the course, data was analyzed to see if a relationship existed between methods of instruction and changes in student perceptions of relevance of biology to everyday life. Due to the changing nature of individuals entering science fields and the role of the female voice, independent of context (Gilligan, 1982) gender was also analyzed to see if this relationship is gender influenced.

Rationale

Based on current literature regarding methods of instruction and non-major student interest in biology, a gap in research exists regarding the relationship between methods of instruction and changes in non-biology major student perceptions of relevance of biology content to everyday life. Best practices in science instruction are found within the framework of learning theory. While Piaget espoused that learning could not occur beyond a child's stage of development, Vygotsky found that social learning was key to progression through developmental stages and subsequent cognitive advances (Vygotsky, 1978). Use of Vygotsky's principles gave validity to the use of social learning in the academic environment. Social learning theory has been identified as an effective method of instruction in the design of science courses in higher education

(Lord, 1998). Methods of instruction conform to the social constructivist model, where learning occurs by constructing new knowledge based on previous experience in a group setting (Wink & Putney, 2002). Listed among constructivist methods are cooperative learning in which students work in groups with specific tasks assigned to each individual; inquiry-based learning, where research and investigation are conducted to solve set problems (Oliver, 2007), oftentimes in laboratory settings; problem-based learning, in which students undertake problems and research to identify missing information that is transferable beyond the classroom (Oliver), case studies, a form of problem-based learning in which students use reasonable investigative approaches that pertain to questions, conduct research, utilize data to create conclusions, and present information to educate others (Waterman, 1998); and active learning teaching strategies in which students engage in ongoing dialogue with immediate evaluation providing feedback that allows the instructor to alter the course of the lecture (Freeman, 2007).

Each instructional method promises of learning gains and improved student interest in the course. Yet, each comes with additional instructor demands for course revision, logistical challenges of implementation, and increased grading. Some instructors are discouraged from change, while others modify strategies and incorporate elements of various strategies to improve student interest (Lord, 1998). While each method of instruction has its pros and cons, no studies have evaluated student reported experiences with various methods of instruction for their effects in non-major biology courses on student perception of relevance of biology content to everyday life. This study will allow for the collection of data for the field of biology instruction by assessing social constructivist techniques of biology instruction on perception of relevance of biology content to everyday life in non-biology majors.

According to Gilligan (1982), females have a distinct voice in light of interests, including science. Prompted by the 1976-1977 NAEP Second Survey of Science which showed that girls trailed boys in achievement levels, over the last three decades, studies have been conducted to narrow down possible explanations. Attitudes and opinions of female students were evaluated and indicate that gender issues in science for girls are more complicated than subjects such as math (Kahle & Meece, 2004). In 1988, with the Second IEA Science Study (SISS) in United States, boys entering grade five all the way through grade12 were still scoring higher in biology achievement, with the gender gap increasing with age. By the time these students were in college, throughout the 1980s, women continued to score lower than men in biology (NSF, 1990). In light of gender related studies on science interest, participation, and retention (Osborne et al., 1998; Kahle & Meece, 2004) of females in science, data analysis on males and females will be included in this study. Analysis will include the potential effect of gender on male and female students' changes in perception of relevance of biology to everyday life.

Hypotheses and Research Questions

The quantitative component of this study will address the following hypotheses and research questions:

H1. There is a significant relationship between changes in students' perception of relevance of biology content to everyday life and gender after participating in a post-secondary non-major's biology course.

HO1. There is no significant relationship between changes in students' perception of relevance of biology content to everyday life and gender after participating in a post-secondary non- major's biology course.

Research Question 1: Is there a significant relationship between changes in students' perception of relevance of biology content to everyday life and gender after participating in a post-secondary non-major's biology course?

H2. There is a significant relationship between students' experiences with various methods of instruction in a non-major's biology course and students' perception of relevance of biology content to everyday life.

H02 There is no significant relationship between students' experiences with various methods of instruction in a non-major's biology course and students' perception of relevance of biology content to everyday life.

Research Question 2: Is there a significant relationship between students' experiences with various methods of instruction in a non-major's biology course and students' perception of relevance of biology content to everyday life?

The qualitative part of this study will address the following research questions:

Research Question 3. In what ways do student experiences with various methods of instruction used in the lecture and lab components of post-secondary biology affect student perception of relevance of biology content to everyday life?

Research Question 4. In what way does gender affect changes in student perception of relevance of biology content to everyday life after participating in a post-secondary non-major's biology course?

Significance of the Study

Osborne, Driver, and Simon (1998) propose that scientific literacy is essential to maintain a participatory democracy. According to the National Science Education Standards (National Research Council, 1996) all individuals should be equipped with the content and skills to become and remain life-long learners. Due to the nature of the magnitude of content to be covered in the typical higher education non-major biology courses, there is rarely enough time to cover content. In the race to cover the vast amount of material, little time is left for the practice of skills and moments for student engagement are missed, thus minimizing meaningful learning (Lord, 1998). Utilizing various instructional methods may result in immediate measureable learning in students with scores that reflect student ability to pass examinations over content. Instructors may however, be over-looking a serious component necessary to shaping lifelong learners at the higher education level. Assessing student perception of relevance is a valid method of assessing the success of methods of instruction. Findings from the study provided formative feedback for the methods of instruction currently in use in higher education non-major biology courses bearing out which, if any, strategies being used, students' perception of relevance of biology to everyday life.

With information being generated at incredible speed, individuals must become engaged and take a personal interest in learning about topics that affect their personal life. In finding appropriate methods of instruction, instructors will be better informed to teach students in such a way that students perceive biology content relevant to everyday life. Consequently, by teaching the knowledge and skills needed in order to survive in an information rich society and make sound decisions regarding science issues, students will be better equipped with biology knowledge to make informed choices about their lives and the planet. As an extension, future ethical choices will also be informed, bringing the reality of biology education in higher education closer to the goal of the NSES, to create informed decision makers and positive contributors to society in the future.

Definition of Terms

Active learning teaching strategies: methods used to prompt student participation in lecture with immediate feedback, providing instructors with dynamic formative evaluation that can alter lecture direction and content in the moment (Freeman, 2007).

Constructivism: a learning theory in which knowledge is an ordering and organization of new information gained by experience (von Glasersfeld, 1984).

Cooperative learning: a student based, constructivist teaching technique in which students work in teams (Lord, 1998).

Inquiry-based learning: a structured form of problem-based learning in which scaffolding and support are blended in research and investigation activities in response to student questions about topics in science (Oliver, 2007).

Perception of relevance: a student's ability to set science in everyday context (Osborne et al., 2003).

Problem-based learning: common in the learning of science and medicine in which students solve complex problems combining the application of knowledge and strong contextual elements to support their learning (Oliver, 2007).

Assumptions and Limitations

The assumptions inherent in the study were be taken into account when suggestions for future research were proposed. Due to the nature of research, limitations are an inevitable component of any study (Bartling, 2009). According to Leedy and Ormrod (2005), assumptions and limitations are an important component of a research proposal. Because assumptions are the product of the researchers point of view, but do not reflect concrete evidence, stating assumptions is critical for the credibility of the proposal (Berg, 1998). Disclosing assumptions may help reduce misunderstandings (Leedy & Ormrod, 2005).

Assumptions

1. That the instruction given in the course was given using various methods of instruction.

2. That at the end of instruction, the students are able to remember and communicate the various methods of instruction that were used.
3. That change in student perception of relevance was due solely to the various methods of instruction being used in the course.

Limitations

1. The research study will be limited by the willingness of the participants in the chosen four year liberal arts college.
2. The study is significantly contextualized in the setting of a single higher education teaching institution. As such, and due to the size of the institution it limits the ability to generalize to other higher education institutions (Leedy & Ormrod, 2005).
3. The study is limited to the instruction of three topics normally covered in a general education biology course: the chemical nature of biology, cell-to-cell communication, and genetics.
4. Because of the size of the institution, the study is limited to one instructor for the course topics under study.
5. The sample does not represent all students' experiences with various methods of instruction used in higher education non-major biology courses.
6. Religious views may affect perception of relevance of biology to everyday life.

Nature of the Study

The nature of the study was mixed methods involving surveys for the quantitative component and a case study with the use of focus groups for the qualitative component. The quantitative component of the study was in the form of Likert based surveys. The qualitative component, the case study, involved the collection of data from focus groups discussions employing qualitative generic inquiry. Case studies are used when incorporating the views of the participants in understanding the relationships under study in the research (Zonabend, 1992). Provided the goal of the study is established with parameters (Tellis, 1997), even a single case can be used to generalize for a greater population if it meets its proposed goals. In this study the single case was defined to be a single general biology course, taught in two sections with a total of ninety six students offered during the spring semester of 2011.

Strategies of inquiry that involve collecting data simultaneously or sequentially to best understand a research problem employ mixed methods research (Creswell, 2003). Mixed-methods eliminate the biases inherent in single method studies (Creswell). The focus of this mixed method study, within the context of a higher education non-majors biology course, was the relationship between perception of relevance of biology content to everyday life and methods of instruction used in the instruction of the course by gender.

Collection of Data

Quantitative data was collected from 96 students enrolled in a higher education general biology course taught at a university in the Midwest. The course itself was designed for non-biology majors. Data was collected by using the revised Likert based Salish I study (1997) survey on perception of relevance. The identical test was administered before and after the cell-to-cell communication, genes and proteins, and patterns of inheritance units were taught in class. The post-test included a survey composed of questions about instructor behaviors observed in instruction and activities used in each topic of the course. Students responded to questions that began with lecture. Other questions indicated behaviors as defined by studies on cooperative learning by Slavin (1995), active learning teaching strategies by Freeman et al. (2007), problem-based learning by Waterman (1998), and inquiry-based learning (Udovic et al. 2002).

The student participants were chosen using a purposeful sampling method. Qualitative data was gathered using the generic inquiry approach. Qualitative generic inquiry is purposeful when four key components are defined in the study (Caelli, Ray, & Mill, 2003):

1. The theoretical positioning of the researcher;
2. The congruence between methodology and methods;
3. The strategies to establish rigor; and
4. The analytic lens through which the data are examined. (p.5)

Focus groups, composed of 16 students divided into two groups of five and two groups of three (Morgan, 1997), who participated in a post-secondary non-major biology course were used to collect qualitative data on student experiences in the course. Students were enrolled in a single lab section that meets once a week. Lab sections were randomly selected and students were randomly asked to participate in focus groups to provide a nearly equal sample of gender. According to Krueger and Casey (2009), the moderator should be respectful of participants, understand the purpose of the study and topic, can communicate clearly and openly, not defensively, and can get the most useful information. Consequently, the moderator was the principal investigator. Discussion groups were recorded and transcribed for accuracy of collection of data, as the goal was to capture the results in a written form (Krueger & Casey, 2009). Discussion questions focused on the instructional behaviors and class activities that affected the students' ability to see course content as pertinent or applicable to their life. A copy of the questions can be found in Appendix B.

Data Analysis

Correlation was conducted by utilizing patterns generated in the data gathered from the changes in the pre/post Perception of Relevance Survey and the Student Experience Survey. Perception of Relevance Survey results were analyzed using ANOVA for main effects and interactions with significance between pre and post perception of relevance scores, topics, and gender. Descriptive statistics from the Student Experience Survey was used to determine if a relationship existed between changes in perception of relevance and the frequency of methods of instruction used in the course. Data from the Student Experience Survey were also used when interpreting focus group discussions.

By transcribing each focus group discussion session, responses were color coded to help identify common themes that emerged from the participants' responses. This form of analysis is referred to as sequential thematic analysis (Percy & Kostere, 2008). Commonalities between student perceptions of the instructor's behavior and class activities revealed in the focus groups, and the identified methods of instruction, according to the researcher's list of behaviors for each method along with the data from the Student Experience Survey provided insight to the changes in perception from the quantitative component of the study.

Organization of the Remainder of the Study

This chapter has addressed the need for sound scientific instruction and the role of student interest in meaningful learning and current teaching practices in non-major biology courses in higher education. The second chapter will review existing literature on learning theory, more specifically social learning theory and its evolution into constructivism as a means of addressing the needs of learners in higher education. In addition, the chapter will address models of instruction, use and effectiveness; the National Science Education Standards and application in higher education; and the role of perception of relevance in learning. The third chapter will address the methodology for this study. Mixed method in nature, the need for a quantitative component will be addressed as well as a qualitative component in the form of focus groups and generic inquiry. Chapter four will contain the data gathered for the quantitative component as well as the responses in the form of narratives of the student focus groups. The fifth chapter will contain the summary, discussion, and conclusions of the study, focusing on the methods of instruction associated with the greatest changes in student perceptions of relevance of biology content to everyday life. Recommendations will follow for use of methods of instruction that provide for positive changes in student perceptions of relevance, with cautions for those that decrease student perceptions of relevance. Recommendations will be included for future research on the relationship between methods of instruction and student perception of relevance of biology content to everyday life

CHAPTER 2. LITERATURE REVIEW

Introduction

Studies on student interest in biology, measurable learning in biology courses, and entrance and retention in biology fields in higher education vary. Some studies measure for the effect of interest (Francom et al., 2009), measureable student learning in science (Knight, & Wood, 2005), and biology program entrance and retention (Seymour & Hewitt, 1997; Sorensen, 2000; Sjoberg & Schreiner, 2005; Kidman, 2008) identifying key variables that attribute to the success or failure of the design of the course or program. Studies range from collection of data on existing programs (Sjoberg & Schreiner, 2005; Brommer, 2007) to experimental designs (Firooznia, 2006). Others attribute gender as the main determinant in interest in biology (Gedrovics, Wareborn, & Jeronen, 2006; Seymour & Hewitt, 1997; Kahle & Meece, 2004). Regardless of the type of the study, the basis for identifying instructional variables within a college biology course that are effective in promoting student learning is an understanding of learning theory.

According to Ormrod (2004), learning is observed when a change in behavior is seen. A learning theory is composed of a set of constructs that ties together changes demonstrated in performance to the elements thought to bring them about (Driscoll, 1994). How that is interpreted is determined by the theoretical perspective considered at the time. Studying how people learn has provided the framework for pedagogy and best practices in educational settings.

Higher education instructional strategies have evolved in attempts to improve college teaching (Brainard, 2007) student interest in and understanding and appreciation of the role of science in their lives (Travis & Lord, 2004). Researchers using an understanding of social constructivism in the development of methods of instruction have constructed an array of methods of instruction utilized on university campuses. Methods include cooperative learning, active learning methods of instruction, problem-based learning (primarily case studies), and inquiry-based learning. While many students perceive their lives disjointed from biological processes, the content that students find interesting often relates to what is applicable to their lives (Gallucci, 2006). Of all the methods of instruction, Gallucci (2006) did note that cooperative learning tended to improve perception of relevance; however, gender differences are not included in the study. Since 2006, in a cited study search of 360 search results containing fifteen journal articles citing Gallucci's work, none have evaluated student perception of relevance. One dissertation, Skolnick (2009) assessed the effect of case study teaching in high school biology on achievement, skills in problem solving and teamwork and attitudes, with questions about personal relevance embedded in the 30 question Constructivist Learning Environment Survey (CLES), but did not report the data in positive, neutral, or negative changes in students' perceptions of relevance of biology to everyday life.

The establishment of standards designed to equip every person in United States with a basic knowledge of the living world and an understanding of how to solve problems has been the role of the National Science Education Standards. Standards at the university level are on the horizon (Crosby, 1996; National Academies, 2010; French, Cheesman, Swails, Thomas, & Cheesman , 2007). How does a governing agency determine essential content without establishing all of the components that foster meaningful learning? Though the content that students have had access to during their 13 years of instruction prior to college is the basis of entry for college students, little research has been done to study the significance of the role of perception of relevance of biology to everyday life in males and females enrolled in higher education non-biology major courses. Identifying its role, if any, may inform future pedagogical and curriculum reformation.

Learning Theory

The search for an understanding of how people learn has been an on-going march toward a moving light. Learning theory, as a discipline provides an explanation of the mechanisms involved in the learning process (Ormrod, 2004). Allowing for synthesis of myriad research studies and principles of learning, learning theory gives a starting point for conducting research, helps make sense of research findings, and most importantly, explains how it has changed over time (Ormrod).

Paradigm Shift from Behaviorism to Social Cognitive Learning Theory

Beginning with the "blank slate" nature of organisms, early learning theory focused on changes in behavior in the classic stimulus response relationship (Ormrod, 2004). Evaluating learning became a matter of observing a change in behavior. Behaviorism has several educational purposes including habit strength, increasing positive emotions while learning academic content, eliminating negative behaviors, and providing clear indices when learning has occurred.

Awareness that individuals learn in social settings, many of the early studies on social learning theory began with changes post-industrial revolution, in the early 1900s, where the progressive John Dewey, focused on a learner centered experiential approach to teaching and learning (Wink & Putney, 2002) in the classroom. Tolman's (1948) experiments, in the name of behavioral science (Bush, 2006), were first in the new wave of research seeking explanations for changes in behavior that did not fit the connectionist mold of the traditional behaviorism. How people think, otherwise known as information processing theory, was pioneered by Tolman and the early theories of Gestalt, Piaget, and Vygotsky (Ormrod). According to Ormrod, use of Vygotsky's Zone of Proximal Development ZPD to guide students through challenging tasks promotes maximum cognitive gain (Ormrod, p.171).

In the 1960's cognitive psychology became the predominant means of studying learning (Bandura, 1977) led by Bruner, Ausabel, and Robinson (Ormrod, 2004). Social cognitive theory advocates that learning can occur as people observe behaviors of others as well as outcomes of those behaviors. It can also occur without a change in behavior of the observing individual. In addition, consequences of behavior and cognition play a role in learning (Ormrod). According to Bandura (1977), social learning is a dynamic equilibrium reciprocating between cognitive, behavioral, and environmental conditions.

Constructivist Learning Theory

In the past 35 years of educational research, it has become increasingly apparent that learning does not just occur as a matter of absorption upon exposure to the information (Ormrod, 2004). To make sense of and organize information, learning is now believed to be constructed from previous knowledge and the acquisition process of new information. While Piaget advocated that development occurred through cognitive stages, Vygotsky focused on the role of social development, defending its role preceding cognitive development. Social interaction precedes cognition according to Vygotsky's theories (Wertsch, 1988). With a more knowledgeable other (MKO), an individual is ushered into new learning, through a phase called the zone of proximal development (ZPD). This scaffolding of information and instruction to allow an individual to make sense of their world is referred to as constructivism (Driver & Oldham, 1986). True grounded constructivist environments promote individual construction of personally relevant meaning by supporting groups or individuals working with multiple points of view, learning how to reconcile differences found in conflicting perspectives (Barab & Duffy, 2000). Because the way individuals develop personal constructs, is based on their experience with the physical world and informal social interactions, it is recommended that acknowledging and building these opportunities is important in science classrooms (Claxton, 1983). Differential gender treatment in these formative processes, leads to gender differences in science fields as evidenced in current data (Blickenstaff, 2005). Though constructivism is pre-eminent in science, there is little agreement in the understanding of how the process of knowledge construction occurs (Palmer, 2005). Application in the academic environment can take many forms.

Applications of Constructivist Learning Theory

The school environment provides the social contacts as well as cultural context within which learning takes place (Vygotsky, 1978). With teachers providing guidance or scaffolding, students are encouraged to participate in activities that expand their cognitive abilities (Ormrod, 2004). The cognitive processes involved in constructivism allow students to make sense of their world (von Glasersfeld, 1987).

Cognitive as well as situated, constructivism combines instructor attentiveness to what is going on in the mind of the student, and observation of successful students' engagement in learning activities (Sandell, 2007). Motivation also plays a key role in the constructivist classroom (Palmer, 2005) as well as student ability to connect pre-existing knowledge and beliefs to what is being taught through experience (Von Glasersfeld Glasersfeld, 1987). Student cognitive engagement is the hallmark of constructivist classrooms (Wink & Putney, 2002). Though criticized for the lack of instructor control, learners contribute greatly to the learning environment, while the teacher still directs the path of learning (Ormrod, 2004). Some criticisms are based on constructivism's epistemological relativism and the dualist view of its ideological aspect, creating the very problem that it was purposed to avoid (Liu & Matthews, 2005). Much of the confusion is based on misinterpretation of Vygotsky's (1978) theories, especially monism. According to Liu and Matthews (2005) while traditional monism advocates a universe made of one substance, Vygotsky's (1978) interpretation disaggregated that one substance to mean all of the components work together. It is this foundation that lays the groundwork for three themes of Vygotsky's (1978) work: observing the mind is the best way of learning about it, higher mental functions are birthed in social activity, and these functions are aided and controlled by tools and signs (Hausfather, 1996). Where students are given opportunity to explore with manipulatives in a social setting, it is in Vygotsky's (1978) socio-historic approach to cognitive development that we find the foundation for social constructivism.

Methods of Instruction

In the constructivist classroom, instructors may use a variety of models of instruction that conform to constructivist pedagogy. According to Osborne et al. (2003) there is no single universally appealing method to teach biology. There are however, many ways to attempt to improve student interest and learning gains. Among constructivist strategies used in higher education are cooperative learning, active learning methods of instruction with and without the use of personal response systems, problem-based learning, and inquiry-based learning. Many studies include analyses of these methods of instruction (Lord, 1998; Freeman, 2007; Smith & Murphy, 1998; Wallace, Tsoi, Calkin, & Darley, 2003; Chin & Chia, 2006). What remains to be determined is how and to what extent male and female students' perceptions of relevance of biology content to everyday life are affected after instruction using these strategies in higher education non-biology major courses.

Cooperative Learning

Over the last 30 years, studies (Astin, 1985; Tinto, 1987) have found that many students, upon completion of biology courses could not apply the content of the course to situations in everyday life. Lord (1998) proposes that the disconnection between learning and application exists due to the way science was being taught laying the blame on the pressure to cover a growing body of content in biology classes as well as content driven exit exams. Cooperative learning provides students time for interaction between old and new information as well as communication between other group members making the time in class student-directed (Lord, 1998).

According to Bouda, Cohena, and Sampsona (1999) cooperative learning is increasingly being used in higher education to address a variety of learning outcomes. In the Johnson and Johnson model (Johnson, Johnson, & Smith, 1998) cooperative learning's most widely used definition refers to instruction where students work in teams to accomplish a common goal, in an environment in which instructors provide for the following criteria to be met:

1. Positive interdependence: where each team mate must contribute or the whole team fails,
2. Individual accountability: where each student has their own component of the work, but is expected to master all of the material,
3. Face-to-face activities promoting interaction: in which some of the activities are accomplished interactively where team mates provide reciprocal feedback as well as encouragement,
4. Appropriate use of collaborative skills: including but not limited to trust-building, leadership, communication and conflict resolution, as well as decision making, and
5. Group processing: by setting group goals, assessing progress, and identifying changes to be made to improve outcomes.

Cooperative learning is best accomplished when students engage interactively with others (Slavin, 1995) rather than in traditional lecture courses. A key assumption is that students working together in a group will teach and learn from each other (Haller, Gallagher, Weldon, & Felder, 2000) Cooperative learning often involves peer instruction. Several of the methods are known as Peer Instruction (PI) (Crouch & Mazur, 2001), Peer-Led Team Learning (PLTL) (Varma-Nelson, 2006), Peer Education (Haller et al., 2010), Team-Based Learning (TBL) (Carmichael, 2009), Small-Group Peer Teaching (Tessier, 2007), among other generic terms for methods of instruction that incorporate part or all of the criteria for cooperative learning.

Groups of students normally range in size from four to five (Slavin, 1995). With a wide variety of structuring possibilities, cooperative learning is easily modified, based on the intent of the instructor. Instruction for the group is typically determined by the instructor. Even the time limitation can be modified to accommodate specifics of the learning goals of the team project (Slavin).

While easily adaptable to a wide range of contexts, disciplines, and instructor styles, the results of cooperative learning experimentation in other higher education courses have had mixed, but overall favorable results. Physicists and physics teachers have long recognized that traditional lecture has little effect on student learning (Crouch & Mazur, 2001). Used in calculus and algebra based intro to physics courses for non-math majors, the Crouch and Mazur (2001) combined the use of one traditional lecture and the remainder of the time for discussion that included the instructor and cooperative learning, where students were placed in groups to meet, discuss, and work together each week for the whole semester. Peer instruction was used throughout the sessions and the instructors noted that the peer instructed cooperative learning necessitated students to be more actively involved as well as more independent in their learning than in traditional courses (Crouch & Mazur).

In a similar study, Felder (2000) used cooperative learning in five chemical engineering courses in a cohort spanning five semesters. His findings indicated a superiority of their performance over the traditionally taught courses, and in 52 respondents of the 75 that were sent surveys five years after completion of the series, every respondent spoke positively about group work and its benefits, mentioning skills, success in the course, and improved self-confidence due to the group interactions.

Varma-Nelson (2006) used cooperative learning in the model of instruction referred to as Peer-Led Team Learning in chemistry. With the use of trained peer leaders to lead groups, data revealed that in math and science gateway courses for diverse populations, retention and grades improved for all students independent of gender or race.

In the Knight and Wood (2005) study comparing a traditional lecture with a more interactive format using the same course syllabus, the researchers incorporated cooperative learning in the interactive course. Using gender balanced groups, the most significant difference in result was in learning gains for the interactive class (60%), with a higher positive correlation between learning gain and grade achieved (.54). In the traditional class learning gains totaled 26% and a less significant positive correlation between grade earned and learning gain (12).

Carmichael (2009) compared a traditional lecture format introductory biology course, with a section of the same course using team based learning. In addition to the traditional lecture format in the second section, Carmichael added cooperative learning placing students in groups of four to six. Data indicated that students in the team based learning section scored higher in exams than did the students in the traditional course. While individual exams were higher, students from both sections' scores were nearly identical on the final exam, leaving question about long term learning.

Using small group peer teaching in an introductory biology class, Tessier (2007) found that this form of cooperative learning benefited students with the lowest grades the most. The study involved elementary education majors in a course that incorporated lecture and student groups of four. The results of the study indicated that students scored better on self-taught and student taught questions than lecture taught questions.

Though results of cooperative learning have shown to be primarily positive in nature there are other related issues that must be addressed. Types of communication, gender, training of teaching assistants and attitudes of instructors affect instructional outcomes when attempting to incorporate cooperative learning.

While using the cooperative learning model to study the interactional dynamics among engineering students and implications for engineering education (Haller et al., 2000), several impediments were discovered. The study discovered several types of students that interfere with cooperative learning dynamics. Identification of these individuals is necessary so that remedial instruction can correct the communication pathways that foster collaborative skills: including but not limited to trust-building, leadership, communication and conflict resolution, as well as decision making (Johnson et al., 1998), central tenets to cooperative learning.

Gender also has a bearing on the success of cooperative learning. Kahle and Meece (2004) report that with traditional classroom dynamics in early years of instruction, greater interaction patterns result in greater opportunities for males than females. While whole class activities foster male dominance, females take a more active role in cooperative learning; however, are less likely to assume a dominant role in the group (Kahle & Meece). In the Haller et al. study (2000) results indicated that in groups with only one female, the role of the female was compromised.

Pedagogically, constructivist methods present challenges (Lord, 1998) resulting in the lack of implementation at the higher education level. Even though a moderate shift toward cooperative learning shows improved learning gains over traditional methods, most teachers don't want to change (Lord, 1998; Varma-Nelson, 2006). Carmichael (2009) attributes large enrollments, not enough assistance and little incentive to implement creative approaches. Though data indicate benefits to incorporating cooperative learning, Knight and Wood (2005) list colleagues' concerns about the time and effort involved in course revisions, fear that student outcomes could not be reliably assessed, and fear that changes would take both student and instructor out of their comfort zone. Though Francom, Bybee, Wolfersberger, and Merrill (2009), in a newly designed peer interactive Biology 100 course, note that a major trade-off is sacrificing depth over breadth, Knight and Wood (2005) propose using purposeful homework assignments to cover content. Another instructional concern is the academic reliability of group leaders and teaching assistants for more formal cooperative learning groups (Crouch & Mazur, 2001). Logistically, Knight and Wood (2005) note that traditional classroom seating does not foster group work.

Studies citing measureable outcomes, attitudes toward science, gender, communication skills, quality of instructor assistants, and the design of the physical classroom have all been addressed; however, no study has addressed how male and female student perception of relevance of biology to everyday life is affected by cooperative learning. Noting the effect of cooperative learning on male and female students will provide insight to instructors of non-major biology courses for preparation of coursework using best practices, in the hope of reaching most, if not all with meaningful learning that equips students with knowledge, skill, and ability to navigate a rapidly changing information society while making informed choices about their quality of life and the longevity of the planet.

Active Learning Teaching Strategies

According to Hammond (1997), students engaging in genuine action and personally relevant activities, have opportunities to use real experience to test preconceptions and misconceptions. He also indicates that activity-based learning can improve students' communication skills with new technologies. It has long been known that active learning is better than passive learning (Scholes, 2002) and traditional lecture in college courses lacks learner involvement (Litchfield, Mata, & Gray, 2007). Within the context of this constructivist based study, active learning teaching strategies refer to specific tasks that occur in instructional settings to engage student interest in a topic.

While many constructivist methods are considered active, this list is taken from the Freeman et al., (2007) study. Instructors provide specific in-class tasks which include case history discussions, in-class questions with immediate feedback using a card system or clickers (a personal response system), think/pair/share exercises, muddiest point writing, exam question writing, minute papers, and discussion of exam questions from previous quarters. Other in-class active learning teaching strategies include concept maps, role playing, models and demonstrations, and debates (Freeman, 2008). McClanahan and McClanahan (2002) used think/pair/share along with a debriefing discussion and variations of other strategies, such as matrix, similar to concept maps in procedure, a study journal, using the concept of the muddiest point and Plus/Delta giving the students a chance to indicate which components of the course helped and didn't in their understanding of concepts. Each strategy involves immediate feedback, a powerful formative aspect of active learning teaching strategies (Litchfield et al., 2007) and Freeman (2008). Rich immediate feedback ranks among Bain's (2004) list of what college teachers do best.

In the Litchfield et al. (2007) study, students chose their own activity and instructors found that the activities fostered engagement and discussion among students during each class. Hakes's (1998) study on interactive engagement in physics education was in response to the data that suggested traditional passive learning imparted little conceptual understanding (Arons, 1997). Making substantial use of activities that provided immediate feedback through discussion with peers and/or instructors, and comparing with traditional lecture/laboratory courses, Arons (1997) found that active learning can increase mechanics-course effectiveness considerably more than with traditional measures.

Studies in biology courses provide useful data on active learning teaching strategies. Allen and Tanner (2005) propose active learning teaching strategies which don't require major revamping of curriculum. Using activities strategically placed at the beginning, middle and end of class at approximately 10 to 20 minute intervals provide for greater participation in this student centered framework. Using student response cards marked A, B, C, & D for in-class multiple choice questions followed by think/pair/share activities included a brief instructor led whole class discussion, allows for infusion of active learning teaching strategies without restructuring the course curriculum or creating more grading for the instructor.

The Freeman et al. (2007) study was conducted in several large classes of biology majors. The courses using active learning teaching strategies were compared to traditionally taught biology courses. Students used a personal response system (clicker) to answer in-class multiple choice questions. Graphic results could be displayed for the entire class to see and student responses were recorded. Data indicated that students in the interactive course design, especially when they were given points for answering clicker questions, not only performed better than the traditional course with higher exam scores and higher scores on identical midterm exams, but also demonstrated declining failure rates. In addition, attendance was higher in classes using the clickers and attendance and course grades were positively correlated. In a surprising finding however, there was no difference in the final exam scores.

In another related large enrollment introductory biology course, Sokolove (1998) found using a multiplicity of active learning teaching strategies promoted participation in a large lecture setting. Sokolove used a combination of cooperative learning, small and large group discussion and in class written responses. Based on Johnson, Johnson, and Smith's (1991) study that determined that students learn higher order thinking skills while actively engaged in dialog, Sokolove (1998) had students wear name badges to foster familiarity. Students provided the instructor with written questions (similar to muddiest point papers) and the instructor was able to identify misconceptions and misunderstandings to be addressed in the next class. Crossgrove and Curran (2008) introduced the use of internet based questions as a warm up assignment prior to instruction, for the instructor to peruse to determine student knowledge base. Keller and Suzuki (1988) reported that adapting instruction to learner misconceptions, interests, and preferences stimulates relevance for the students.

Knight and Wood (2005) propose that even a partial shift toward interactive collaborative strategies in the classroom can foster significant student learning gain increases. This is evidenced by their experiment in large traditionally taught biology courses by partially changing one course with active learning teaching strategies. The students in the course taught with active learning teaching strategies had better conceptual understanding and normalized gains were higher for the interactive courses. The Knight and Wood (2005) study, as well as the Smith et al. (2005) data, show that think/ pair/ share with peer instruction has shown improved student learning. Crossgrove and Curran (2008) also found that with very little *true* active learning teaching strategies, students scored as well or better than the students in traditional biology courses.

Knight and Wood's results indicated that students with A and B grades responded with higher learning gains in the active learning course as opposed to the traditional course. C students demonstrated lower learning gains in both. Beichner and Saul (2003) whose work was in elementary physics courses, found that their students' ability to solve problems, conceptual understanding, and attitudes improved, with failure rates for women and minorities decreasing. Though at risk students fared better in later "static" engineering courses. Interaction between the students and instructor seemed to be the key to success of the method of instruction.

Recommendations of the study suggest that active learning teaching strategies should be introduced in introductory courses and continued throughout the curriculum. While the greatest resistance came from juniors and seniors who already felt like they had discovered their own learning style and systems for learning, starting interactive learning early in a college career may be motivational for biology majors to remain in their major (Knight & Wood, 2005).

As in other studies there was some resistance from students who did not like group work. Helping others learn without any personal benefit irritated the competitive students. Some students indicated frustration with having to learn outside of class.

Crossgrove and Curran (2008) compared the use of clickers in active learning between a biology majors' genetics course and a non-major biology courses and retention of knowledge using another teaching technique JiTT (Just in Time Teaching). Students were given internet based questions prior to instruction so that the instructor could assess the knowledge base of the students and adjust instruction. Using in-class multiple choice questions, followed by think/pair/share activities, both groups demonstrated positive opinions on the use of clickers. While the study showed that both courses scored higher than traditionally taught courses without the use of active learning teaching strategies and clickers, the most dramatic result was in the differences in test scores between majors and non-majors that did use clickers, with non-majors scoring better and having more positive responses about the use of clickers in instruction. In addition, four months after the courses, students were re-tested for retention and the non-majors scored better.

McClanahan and McClanahan (2002) limited their study to non-biology majors conducting mini-lectures and in-class active learning teaching strategies. McClanahan and McClanahan (2002) propose that active learning strategies generate more student questions, corroborating the findings of Knight and Wood (2005) and that this allows students to deconstruct difficult concepts. Students used study journals that instructors could collect and read, indicating questions and areas of misunderstanding (muddiest point exercise). Further analysis indicated that students were able to focus on and increase their understanding of biology concepts.

Many instructors find change daunting. Freeman (2008) proposes several reasons for the resistance to utilizing ALTS in the courses. Changing lectures to accommodate new teaching techniques takes time and can create grading nightmares. To overcome such obstacles peer and administrative support is necessary (Freeman, 2008). Many times physical settings are not conducive to the close physical proximity necessary to participate in student activities. McClanahan and McClanahan (2002) also note that the methods of instruction have to be compatible with an individual's teaching style.

Relevance was mentioned in the Litchfield, Mata, and Gray (2007) study, as it was tied to increasing student motivation by promoting student choice of participation between five activities for their class presentation. Making a case for students to learn and retain more content, Litchfield et al. (2007) proposed that when students can be involved in relevant personally interesting activities, they become more engaged. Based on Keller and Suzuki (1988), Sokolove proposes that feedback from the student questions allowing the instructor to tailor instruction to student interest also fosters relevance for students. However, there is a void in the literature regarding the significance of perception of relevance in science instruction. While relevance is reportedly important in motivation, none of the studies have assessed or attempted to correlate the effect of active learning teaching strategies on student perception of relevance of biology to everyday life.

Problem-Based Learning

Problem-based learning is another constructivist method of instruction where learning takes place in student research and investigation of a context-rich problem (Kieser, Herbison, & Harland, 2005). Requiring much more involvement on the part of the instructor, students, and use of class time, problem-based learning can be presented in lecture or laboratories, in problem-based learning, critical thinking, reasoning skills and connecting in-class learning with reality outside are fostered.

A common format of problem-based learning used in higher education is referred to as case studies, where students learn about a problem and are encouraged to engage with characters and circumstances within in the dilemma (Waterman, 1998) to solve it. Students can work on cases as individuals or in groups (Herreid, 2008). Using a narrative, followed by a set of leading questions, Herreid (2008) found that case studies motivate students to research information and develop analytical skills (Udovic et al. 2002; Waterman, 1998). By investigating to understand the facts, values and decisions to be made, students make connections to their own lives.

Case studies can easily be modified to suit a multiplicity of disciplines (Boehrer & Linsky, 1990) and are often used in business schools, such as Harvard, with analysis of case histories prior to attending class (Waterman, 1998), law and medical schools (Hewlett, 2004), psychology, and teacher education (Smith & Murphy, 1998).

All cases contain a description of the problem-based on reality, placing students in the role of the problem solver, and can be classified by the degree to which they are open or closed (Cliff & Nesbitt, 2005). Open ended cases, because of the variety of direction, are student directed, with the success depending on the students' abilities to come to legitimate resolution to the dilemma. The focus of open ended case studies is procedural, fostering higher order process skills in Bloom's (1956) taxonomy such as evaluation and synthesis.

On the other hand, closed ended studies focus on content, which students must have access to, to solve the case. The design of closed ended cases is instructor-directed, with specific content to be mastered using knowledge and comprehension skills at the other end of Bloom’s (1956) taxonomy. The criterion for success is for the student to construct a solid mental model of the content at the foundation of the case. Determined by the instructor, cases can combine both models and incorporate application and analysis in Bloom’s (1956) hierarchy of thinking skills. Closed cases provide time limitations, and cases can include closed as well as open ended components. According to Cliff and Nesbitt (2005), cases should include both to be of the richest benefit to students.

Case studies coupled with cooperative learning methods of instruction teach students to approach problems with critical analysis and provide context within which to communicate the process in a constructivist environment (Hewlett, 2004). Hewlett (2004) tested the use of case studies in three different curriculum areas, evaluating the effectiveness when coupled with peer-led team learning, a form of cooperative learning, in general chemistry, human anatomy and physiology and abnormal psychology classes. The staff attended a work shop at The University of Buffalo to learn how to develop valid case studies for each discipline area. At course completion, quantitative data was collected to compare the percent of grades A, B, and C earned in case study courses and traditionally taught courses. Non-case study courses (n=105) resulted in 78% with case study courses (n=68) at 87%. Qualitative measures in the form of student surveys indicated that the case studies facilitated a deeper understanding of the course concepts.

Using realistic cases, in which students can relate learning to life and provide opportunities for students to see the role of science in society (Hobson 2000/2001). Making connections between science and everyday lives is a critical element of science education reform proposed by AAAS (1989) and the NRC (1997). Woolnough (1994) points out that many factors of effective science teaching are outside the control of educators; however, methods including case studies make science teaching more effective. For the cases to be successfully, however, they must be congruent with the instructors' goals and objectives (Gallucci, 2006).

The National Center for Case Study Teaching and University of Buffalo has created a repository of case studies. Each case is composed of characters, dilemmas, and questions placing students in the center of scenarios with expectations of finding possible resolutions, with plans to publish 100 new case studies yearly on the center's website. Case studies are more likely to be used in a college literature course however, use in the sciences has provided noteworthy research and results (Berry, 2000). Often used in undergraduate courses, Gallucci (2006) proposes that case studies address problems facing higher education biology and that case studies increase student interest by focusing on the relevance of the subject matter.

Smith and Murphy (1998) advocate case studies as an alternative method for teaching scientific critical reasoning skills, a major objective for undergraduate biology education (NSF, 1989). In several biology courses, Smith and Murphy (1998) used problem-based case studies finding that the flexibility of the method allows for use in lecture laboratories, assessments, stimulating individual and group discussion, and report writing. The student responses collected indicate that the case studies were helpful, made the class enjoyable, and provided challenging opportunities in class. Chin and Chia

(2006) report using ill-structured problems in biology project work created opportunity for additional problem solving and resultant independent inquiry.

When interviewed about science instructors (Berry, 2000), University of Buffalo professor Clyde Herreid states that, “As a professor, your greatest impact is on the non-biology majors” (p.439). Herreid’s (2005) study using the problem-based case study method was in an introductory biology course in conjunction with (clickers) a personal response system in a method referred to as the interrupted case method. Integrating lecture, the case study, discussion, clarification, and more lecture in an iterative process, the results showed increase in attendance, student written support for this approach over traditional lecture, increase performance on critical thinking questions, and a rise in class grades.

The extent of preparation time to implement problem-based learning opportunities is determined by the use of pre-existing case studies or designing originals, the objectives of the cases and the experience level of the instructor (Smith & Murphy, 1998). A limitation to this method of instruction is the logistics of the classroom, with amphitheater seating least conducive to small group discussion and ability of the instructor to get to each group. Group dynamics can also pose problems (Herreid, 1999). Still yet, it is not known the level and form of scaffolding most appropriate for first-year students (Oliver, 2007). Kieser et al., (2005) found that use of problem-based learning in an oral biology class resulted in learning gains in individuals with a surface approach and fragmented conception of learning, and no changes in those who began the course with a deep-learning approach and cohesive conception, citing motivation as a possible explanation.

Problem-based learning has proven to increase student interest and learning gains in several disciplines in higher education, however; there is a noticeable gap in literature on case studies associated with gender influence or bias. Little is known about the effectiveness on learning gains by gender. Though the Gallucci (2006) study indicates that case studies improve interest by making biology more relevant, no study has yet to determine the effect of the use of case studies on student perception of relevance of biology to everyday life. Problem-based learning can have an inquiry component, but for this study, inquiry-based learning will be dealt with separately in the next section.

Inquiry-Based Learning

Inquiry-based learning allows students freedom within their own learning as they explore causation and results of science phenomenon (Waterman, 1998). Science taught by inquiry allows students to experience science rather than learn it as a body of knowledge (Udovic et al., 2002) and to emulate the way a scientist works (Demir, Schmidt, & Abell, 2010). Interest in higher education inquiry-based methods of instruction has been rising (Wallace et al., 2003). Since the announcement of the NSES in 1996, various landmark changes have occurred in biology changing the foundation for biology literacy (Coker, 2009). Due to the rapid rate of advancement of in the sciences, unimaginable decisions at the individual and societal level must be faced in the near future (Firooznia, 2006). Consequently, science education has changed from content to conceptual knowledge, with students needing to be able to apply science to everyday life rather than to recite simple facts (Knight & Wood, 2005).

Wallace et al. (2003) performed the first in-depth study of the effect of inquiry and conceptual learning with data supporting the continuation and development of inquiry-based laboratories, with potential for students to build conceptual knowledge, though some students may need tighter instructional scaffolds. Reinventing Life is an inquiry-driven course designed to introduce student to biological changes in the 21st century. Though the course is designed around a set of learning goals, Coker (2009) points out that the focus is not on topics, rather, "the larger pedagogical scaffold of modern biological change" (p. 283). Results of the study indicate a change in student views on biological change and relevance to their lives, as well as a greater understanding of the relationship between biological concepts and everyday life compared with students in the more traditional courses.

Dimaculangan et al. (2000) have designed a course focusing on the scientific method, with students arriving at a testable research hypothesis that can be completed in two to four weeks. Using this format for pre-service teachers has been more effective in preparing teachers science instruction than traditional courses. Students improved most drastically in ability to select the proper statistical test and knowledge of sources of information.

Firooznia (2006) in an innovative approach to inquiry-based learning uses science fiction to teach a non-biology major inquiry-based laboratory course. Focusing on exploratory laboratories, students formulate hypothesis, design experiments, analyze their data and give report of their findings. Results of the study indicated two-thirds of the students reported an increase in interest in biology and one-third reported that they would consider taking another biology course. Udovic et al. (2002) incorporated investigative activities in the Workshop Biology course to allow students to pose their own problems, methods by which to solve them and defend their conclusions to peers. When compared to a traditional course, concept test scores were higher for the workshop group. Even the course evaluations for the workshop group were significantly lengthier and more thought out than the traditional course responses. Results from the Yager, Kaya, and Dogan (2007) study in a higher education interdisciplinary course using open-ended inquiry-based teaching techniques found that students learned basic science concepts from their own projects as well as from the topics of others in the course. A commonly occurring limitation to inquiry-based learning is the need for longer class periods to accommodate the increased interaction and procedures performed by the students (Wood, 2009; Udovic et al., 2002).

Studies including the effect of gender on inquiry-based learning outcomes are lacking in current literature. Relevance has been addressed by Coker (2009) with respect to students viewing the changes in biology as relevant to their lives, but no study has assessed the significance of inquiry-based learning on students perceptions of relevance of biology to everyday life.

Gender Studies

Driscoll (1994) attributes genetic inheritance and brain physiology as the focal points for biological research related to learning. According to socio-biologists, adaptive behaviors are governed by natural selection of genes for survival traits in conjunction with environmental factors. The classroom and instructional methods, as environmental factors have a significant role in the dynamics of learning. Gender studies in the last 25 years have sought to identify what role gender has on the learning of, involvement in, and success in science and science related fields, especially in females (Kahle & Meece, 2004). Though in the last 20 programs have focused on encouraging women to participate in the sciences, the end result is still yielding limited involvement by females (Fuselier & Jackson, 2010).

Pioneering work in gender studies, Gilligan's (1982) early work finds gender differences based on either social or biological causation disturbing, suggesting the female voice, an unexplored entity, has been suppressed by a patriarchal dominance in research and interpretation of human behavior. Espousing that women have taken a back seat in the development of psychological explanations for "normal behavior", Gilligan proposes that females have yet to take an active role and be recognized in the field of psychology and the study of human behavior. The effect of a differential understanding of genders affects learning in the classroom.

In light of science education, studies have observed different male and female behavior starting in early education years (Osborne et al., 2003). Many countries are experiencing a growing gender gap in students entering science and technology fields

(Sjoberg, 2001). Though many countries have experienced a steady growth period of females entering science fields, it has begun to decline. The earliest United States studies noted that boys and girls receive differential treatment in the typical classroom, resulting in gender differences in attitudes and achievement (Brophy, 1985). This has carried over into the science classroom, where Jones and Wheatley (1990) report that teacher interaction with males was more frequent resulting in greater opportunities for boys to learn science. Studying students in Canada, Adamuti-Trache and Andres (2008) state that influences in the early years, especially those exerted by parents, impact student views toward school subjects, with the secondary years being a critical time in a students' life for career opportunities. The trajectory a student is set on in the secondary years is pivotal for selection of STEM careers (Adamuti-Trache & Bigler) finding in a ten year longitudinal study that females tend to go into more biological sciences where males tend to study physical sciences.

Osborne et al. (1998) noted that positive attitudes toward science peak around the age of eleven and significantly decline after that, especially for girls, citing an eight year evaluation of a balanced and compulsory science education program. Data showed only slight improvement in female choices for college entrance in the biological fields, with the majority not choosing physical science. Attributing the difference to perceptions of difficulty of the fields or the effect of teaching, Osborne et al. (1998) doubt that there is a single universal method of teaching. Weisgram and Bigler (2007) focused their study on the effect of learning about gender discrimination on adolescent girls' attitudes toward and interest in science, finding that girls see past negative successes with discrimination not with lack of ability. Self-efficacy was improved in the study as well as their belief that science is worthwhile to study.

Secondary education experiences also affect gender bias in success in science. Adamuti-Trache and Andres (2008) advocate that the trajectory set in the secondary years in the form of math and science courses is most likely the direction an individual will follow for higher education and career choice. Seymour and Hewitt (1997) have found that lower expectations of females pre-college affect undergraduate science majors as well as science graduates. Pointing out that males tend to get more attention and praise for feedback, with females learning in a more passive, less experiential way, may have some effect on the number of females engaging in science. Other layers in the "filter" proposed by Blickenstaff (2005) that may lead to disparate numbers of women in STEM careers include the lack of role models, irrelevant curricula, cultural pressure, and an inherent masculine worldview in scientific epistemology.

Methods of instruction also play a role in gender related issues. While males tend to dominate whole class activities, females opt for cooperative learning over competitive activities, though in mixed groups, take a less active role (Kahle, 1990). Outside the classroom, gender based socialization also sets up girls for failure in the competitive component of science (Seymour & Hewitt, 1997).

Based on the literature, a deeper understanding of gender issues is needed to determine if there is a difference between males and females and changes in perception of relevance of biology after taking a post-secondary non-biology major course.

The National Science Education Standards and Higher Education

Children in the 21st century are growing up in a society that is driven by relentless science and technological advances. America is faced daily with difficult collective decisions (Schwebach, 2001). Yet, in comparison to Japan at 66 percent and China at 59 percent, United States only has 32 percent of its college graduates awarded degrees in science and engineering (Yankelovish, 2005). Discoveries such as the human genome project, the expanding internet, global warming and a better understanding of the universe have changed the way we look at the world.

Against a backdrop of expanding knowledge, is the arduous task of educating future generations to survive. The goal of the National Science Education Standards (NSES), released by the National Research Council (NRC) in 1996, is to provide an educational basis in science for every US citizen to use to make life-long choices in an ever-changing knowledge churning society. The NSES are inclusive of teacher preparation programs, professional development standards, assessment standards, content standards, science education program standards and science education system standards (Lederman, Hall, Nyberg, & Ritz, 1998). According to Vasquez (1996), the president of the National Science Teachers Association at the time of the standards' publishing, the standards are not a federal mandate, but a vision of learning and teaching science providing an opportunity for all students to achieve scientific literacy. Lederman et al., (1998) refer to the standards as a vision with the goal of improving science teaching and learning. A major change in the NSES is in the focus on inquiry as a method of instruction (NRC, 1996).

Though the standards are focused on K-12 curriculum, Crosby (1996) strongly urges that the standards should be read by all professional educators and incorporated into the lives of all Americans stressing that the "implications imbedded for higher education in the standards are profound. Teachers teach as they have been taught" (p.A201). K-12 reform will produce the greatest gains in scientific literacy; however, Crosby (1996) proposes the vision must start at the top with the acknowledged leaders, colleges and universities.

Traditional biology courses that are taken by non-biology majors are usually one semester and are most likely to be the last science course students will take for life (Marcus, 1993; Scherer, 2007). Some college classes, according to Yankelovich (2005) are designed to weed people out and often discourage others from going into the sciences. Druger (1999) advocates the need to have national standards, especially for introductory classes.

In response to the lack of national accrediting body for biology education in higher education, leaving faculty without guidance in reviewing departments and graduates, French, Cheesman, Swails, Thomas, and Cheesman (2007) collected data from 403 institutions regarding content in introductory biology courses. The data reflects a de facto standard of biology content, which serves to give faculty a platform from which to initiate curriculum reform and give employers and graduate schools an idea of what it means to be a biology graduate. Another solution, posed by Conley (2007) which concurrently addresses the challenge of college readiness, is to align high school and college expectations.

Linking the NSES and higher education, the National Academies new framework project is to develop a framework for core discipline and cross discipline ideas for K-12 science. The goal is also to provide a foundation for discussion of alignment between K-12 and higher education (Crosby, 1996; National Academies, 2010; French et al., 2007). By providing guidance for curriculum development, assessment and serving as a foundational liaison between K-12 and higher education the goal is to increase synergy between science learning in formal and informal settings. Druger (1999) cautions that standards do not raise achievement alone.

According to Siebert & McIntosh (2001) higher education is already positioning itself to align to the NSES, by virtue of its teaching inquiry, a central tenet of the NSES in various disciplines. Fox (1998) reports that reform is common among higher education institutions that recognize the need to change. At Finger Lakes Community College, in Canadaigua, New York, Hewlett (2004) utilizes the NSES recommendations for inquiry-based learning in courses designed to teach critical analysis. At Ohio State University, Biology 101 has been restructured to pilot changes to the curriculum recommendations in the NSES (1996), the Atlas of Science Literacy (2001), and Benchmarks for Science Literacy (1996). The syllabus and lecture notes were written for the course, and though the course was not able to cover the breadth recommended by the NSES, biotechnology was included. Stating that the standards for K-12 are probably good for non-biology major classes, the instructor sees the NSES as a model of how to think, teach and learn. Having students take information from inquiry-based labs and apply it in a new context such as the lecture portion of the course is the definition of learning.

Resistance to higher education standards comes from university professors who are strong on academic freedom Beeth, Adadan, Firat, and Kutay (2003). The NSES are seen as restrictive and change in practices means more work (Vasquez, 1996). In reality they benefit the instructor who aligns courses to be consistent with students' prior learning (Druger, 1999).

The standards provide criteria for effective science education. Clearly it is the goal of the NSES to foster critical thinking skills by formulating questions, reflecting on concepts, constructing explanations, developing deeper meaning, providing opportunity for deeper understanding, and clarifying concepts through conversation (NRC, 1996). Faculty at higher education institutions is slowly adopting NSES in introductory biology courses; however, there are no formal higher education standards. Nearly comprehensive of current pedagogy and best practices, the standards lack a simple component that literature is starting to address as a potential key to meaningful learning. Missing from the standards is the role of student perception of relevance of biology to everyday life in learning gains.

Perceptions of Relevance of Biology to Everyday Life

Traditional didactic lecture does not provide opportunity for student engagement that fosters construction of knowledge nor does it provide exposure to real-world situations that would allow students to make connections to their own point of reference (Chaplin & Manske, 2005). Current literature on learning theory has provided a rich understanding of the basis of best practices used in higher education biology classrooms

(Wink & Putney, 2002). Studies on methods of instruction resulting in positive learning gains supply instructors with various methods of instruction, recommendations for individual and group work, and guidance on implementing student inquiry to replace didactic lecture and cookbook laboratory experiences (Hewlett, 2004; Freeman, 2008; Firooznia, 2006; Knight & Wood, 2005).

Equipped with the NSES, some post-secondary institutions are changing curricula and pedagogy to include process oriented and skill building opportunities to enhance and reform current curricula (Hewlett, 2004). Application of the content to students' lives plays a pivotal role in engaging students (Udovic et al., 2002). According to Chaplin and Manske (2005), because of the tie of biology content to current issues, students are more engaged and motivated to do independent research. Helping students make connections between science and their personal world is a common theme throughout current literature (Hohman et al., 2006; Coker, 2009; Becker & Schneider, 2004).

According to Hanna (2003), higher education institutions face a growing problem of relevance. Several studies address the relevance of science as a result of pedagogy that help students see science as important to their lives (Hohman et al., 2006; Coker, 2009; Becker & Schneider, 2004). In the Udovic, Morris, Dickman, Postlethwait, & Wetherwax (2002) study, relevance was used as a condition of the content selected for a non-majors biology course, in which students reported positively on the importance of connections. Coker (2009) measured the significance of student views on change in biology and its relevance to their life, finding that student understanding of the relationship between biology concepts and everyday life had improved over a traditional course.

Osborne et al. (2003) states that student attitudes toward science are a reflection of perception of relevance, and without this essential ingredient, maintaining student interest is nearly impossible. Relevance is tied to attitudes (Osborne et al., 2003), student ability to make connections between science and everyday life (Udovic et al, 2002; Coker, 2009) and motivation (Becker & Schneider, 2004).

Conclusion

A void exists in literature with respect to constructivist methods of instruction and perceptions of relevance of biology content with a focus on determining gender differences in students taking non-major general biology courses. Though myriad studies have espoused best practices in pedagogy, meaningful learning and assessment strategies, little is known about the effect of methods of instruction in higher education non-major biology courses on male and female students' perception of relevance of biology to everyday life. Determining the effect best practices have on male and female students' perception of relevance of biology to everyday life is significant to instructors in the choice of methods of instruction. By teaching using established effective best practices, science education will progress closer to the vision of the NSES, with the goal of nationwide scientific literacy.

CHAPTER 3. METHODOLOGY

Introduction

Learning theory research provides a rich basis for best practices in higher education biology instruction. Current literature cites successful constructivist practices as measured by increasing student interest in biology, learning gains, retention in biology programs, and improved attitudes toward biology. The NSES provide a body of science knowledge that is recommended in K-12 instruction for every American, with the goal of national scientific literacy. Higher education institutions are now incorporating content and pedagogy recommended by the NSES into courses to increase student interest in biology, learning gains, retention in biology programs, and improved attitudes toward biology. A key element of student attitudes, motivation, and ability to make connections of science to everyday life is relevance. The purpose of this study was to explore changes in student perception of relevance of biology to everyday life and those methods of instruction used in a non-major biology course that may contribute to changes in perception of relevance.

This chapter explains the methods that were used in the study including a description of the design, setting, sampling procedure, population, ethical issues, sampling methods, characteristics and size, instrumentation, data collection, and data analysis procedures. These procedures were guided by the following hypothesis and research questions.

Hypothesis and Research Questions

The quantitative component of this study will address the following hypotheses and research question:

H1. There is a significant relationship between changes in students' perception of relevance of biology content to everyday life and gender after participating in a post-secondary non-major's biology course.

HO1. There is no significant relationship between changes in students' perception of relevance of biology content to everyday life and gender after participating in a post-secondary non- major's biology course.

Research Question 1: Is there a significant relationship between changes in students' perception of relevance of biology content to everyday life and gender after participating in a post-secondary non-major's biology course?

H2. There is a significant relationship between students' experiences with various methods of instruction in a non-major's biology course and students' perception of relevance of biology content to everyday life.

H02 There is no significant relationship between students' experiences with various methods of instruction in a non-major's biology course and students' perception of relevance of biology content to everyday life.

Research Question 2: Is there a significant relationship between students' experiences with various methods of instruction in a non-major's biology course and students' perception of relevance of biology content to everyday life?

The qualitative part of this study will address the following research questions:

Research Question 3. In what ways do student experiences with various methods of instruction used in the lecture and lab components of post-secondary biology affect student perception of relevance of biology content to everyday life?

Research Question 4. In what way does gender affect changes in student perception of relevance of biology content to everyday life after participating in a post-secondary non-major's biology course?

Research Design

The mixed method case study included quantitative survey design components and a qualitative generic inquiry component. The research questions and relevant studies called for a quantitative study of student perceptions of relevance before and after instruction of biology content, as well as an assessment of student experiences in biology courses. However, because information is situational (Fitzpatrick, James, & Worthen, 2004) methods must reflect the nature of the research questions and informational needs of the researcher. The types of questions, degree of control over events, and the chronology of focus provide the basis for the use of case study research.

Case studies have been used in United States since the 1900s (Tellis, 1997) to obtain useful information. According to Yin (1994), the inflexibility of traditional experimental or quasi-experimental research makes case studies the only means of conducting research in specific circumstances. Single case designs are optimum when no other cases are available for duplication (Tellis).

A well-designed case study includes a description of the research, procedures used, research questions that drive data collection and a format for the narrative (Yin, 1994). Descriptive case studies provide the basis for the formation of hypotheses of cause-effect relationships (Yin). To obtain a rich understanding of the relationship under study, the choice of research methods is critical.

Case studies are used when observing contemporary events, include surveys and interviews of participants (Yin, 2003), and are best suited when behaviors of the participants cannot be manipulated. While a more pluralistic view of the exploratory, explanatory, and descriptive case studies is deemed more appropriate by Yin (2003), the case in this proposed study was at a four year liberal arts institution, with the set of students enrolled in the non-majors biology course. The course consisted of two lectures and one lab per week. The case was descriptive in nature due to the relevant research questions of how and why, it has no requirement of behavioral events, and it focuses on contemporary events. Student perception of relevance changes were recorded by obtaining pre and post Perception of Relevance Survey scores. Methods of instruction data were obtained by a Student Experience Survey answered at the same time as the post-test. The qualitative component provided insight from focus groups on the experiences students had while in the course.

Mixed Methods Research

Because the world is not inherently qualitative or quantitative (Yoshikawa, Weisner, Kalil, & Way, 2008, p.344), integrating the two approaches gives a better understanding of the dynamics of a setting, process, or phenomenon under study. Multiple methods may improve the quality of the results of a research study (Newman & Benz, 1998). To determine the dynamics of changes in student perception of relevance of biology to everyday life, this study will take the approach of analyzing quantitative data from the Perception of Relevance Survey pre and post-test, as well as data from the student experiences in the course survey. According to Feagin, Orum, & Sjoberg (1990), in an effort to understand the cultural systems at work in a case study, observing and collecting data on interrelated activities of the participants in a social situation provide a holistic understanding. Data on gender will be used in the proposed study to determine its role in the changes in perception of relevance.

The quantitative component of this case study will involve a survey to determine students' perception of relevance of biology to everyday life before and after participating in a higher education non-major biology course. A second survey will be administered to record student observations of methods of instruction used in the instruction of the course. The qualitative component will use the results from qualitative generic inquiry in the form of student focus group discussions. Hence, the implementation is sequential with quantitative data collected first and qualitative data collected in a separate phase of the study for integration of the findings into the analysis of the quantitative phase (Creswell, 2003). Using the findings of both phases will enable concurrent triangulation corroborate findings (Creswell).

Quantitative Methods

Quantitative research consists of the collection of numeric data from participants answering specific, narrow questions. In cases where experimentation can lead to clearer causal inferences and the experimental design helps to clarify the nature of the problem being studied, quantitative means are the choice method for obtaining reliable data to be used for planning change (Cook & Reichardt, 1979). According to Newman and Benz (1998) measurement validity is essential in the estimation of how well the instrument measures what it proposes to. Design validity is both internal and external. Internal is the measure by which independent variables affect the dependent variable. External validity is the extent to which the study's findings can be generalized to a greater population (p.33). By locating a valid instrument or instruments to conduct the study in an unbiased manner, the researcher gathers data to answer the research questions of the study (Creswell, 2005).

The research design chosen for the first part of the study is quantitative. This component will involve the use of a survey. Surveys provide a numeric description of trends in opinions, behaviors, or characteristics in a large group of people from which the researcher can generalize about the population (Creswell, 2005). According to Creswell, surveys help identify beliefs and attitudes of participants as well as provide useful information to evaluate educational programs (p.354).

Qualitative Methods

Qualitative research can be conducted using a generic inquiry approach (Percy & Kostere, 2008). Mixed design studies can employ the use of generic qualitative inquiry when attempting to determine participant's attitudes about events in which they have participated. The researcher benefits from qualitative generic inquiry as it incorporates the significance of a researcher identified specific variable in the study, eliminating many false assumptions. Caelli, Ray, & Mill (2003) advocate qualitative generic inquiry (QGI), as one form of qualitative research. QGI is appropriate and purposeful when four essential components are well defined in the study.

The proposed study will satisfy the rigor of the components first in the theoretical positioning of the researcher. The intent of the principal investigator in this study will be to identify or reveal the constructivist methods of instruction pertinent to the study. Ensuring the training of the principal investigator is essential to congruence in the study. A narrative of the training of the principal investigator should be included in the analysis of the qualitative data. Another way in which the rigor will be satisfied is in the congruence between methodology and methods. Informed by current literature on research, the methodology and methods of the study are clearly referenced by research experts to provide clarity in carrying out the steps of the study. Strategies to establish rigor are inherent to the study. Error will be limited by using a multiplicity of constant conditions in the administering of the testing instruments and analysis of the data. The final way to establish coherence in the rigor of the study is to identify the analytic lens through which the data are examined. Identification and explanation of assumptions and limitations are stated in the study. Sequential thematic analysis will be used to analyze the qualitative data to establish common themes from discussions and interviews.

Qualitative data can be obtained using a purposive (purposeful) sampling (Creswell, 2007) of the participants. Collection of data is designed to obtain meaningful opinion and insight from participants in a study. Focus groups are composed of four to six participants in the study that can convene and answer questions that have been prepared by the principle investigator (Creswell, 2005). By using focus groups, information may be obtained from discussion with guided questions that may otherwise not have been revealed in individual interviews (Krueger & Casey, 2009). According to Morgan (1997) focus groups can contribute a unique perspective on research of a phenomenon and meaningful information can be gathered, even if not in a naturalized environment.

Setting of Study

The setting of the study will be a private liberal arts university, referred to as Midwest Institute of Higher Education (pseudonym). It is denominationally affiliated with Christian foundations and has a mission to provide an education with a Christian purpose. Its forty acre campus has a faculty of over one hundred men and women. The university is distinguished for high academic standards, values-based education, and personal relationships between instructor and students. Midwest Institute of Higher Education is 101 years old. With renovations and additions in academic buildings and housing students have access to a physical library of over 500,000 books and other items of various formats, as well as state of the art technology providing access to electronic research 24 hours a day.

As a liberal arts institution, the university instructs students in blending the liberal arts and the professional training in their degree programs. Undergraduate academic programs are national and international in nature and include majors, concentrations, and minors in over one hundred areas of study. There are approximately 2500 undergraduate day students. Midwest also offers non-traditional degree completion programs and has an additional 600 undergraduate students in the Adult Studies program. Midwest Institute of Higher Education is divided into the School of Professional Studies, the College of Arts and Sciences, the School of Education and the School of Theology and the School of Graduate Studies which offers degrees in the areas of religion, education, business, counseling, and nursing. The biology department of Midwest Institute of Higher Education employs six full time professors and one full time staff member. The number of biology majors is approximately 140.

Sampling Procedure

Clear identification of the population from which the sample will be taken must be obtained to avoid sampling error. Sampling procedures vary with the most rigorous procedure being choosing individuals using a random numbers table (Creswell, 2003).

Population

The population of the study, from which the study participants were drawn, was composed of college students and professors participating in higher education General

Biology, otherwise known as non-major's biology courses and the laboratory activities that accompany the course. The age span for traditional first time college students ranges in age from 18 to twenty 23 years, with the freshman year beginning at 18 and graduation by the age of 23. Students and instructors have diverse ethnic backgrounds, with most speaking English. Midwest Institute of Higher Education has 2500 undergraduate day students and 600 undergraduate students in the Adult Studies program studying fields in over one hundred majors and minors.

Sampling Method

Non-probability sampling strategies were used to select the participants for the quantitative component of study because the individuals were convenient, available, and all were non-biology majors, integral characteristics for the study. Convenience sampling is defined as using the population on hand (Creswell, 2005). Because the principal investigator was employed at Midwest Institute of Higher Education and the participants were already enrolled in the General Biology course, utilizing the existing population at Midwest Institute of Higher Education was convenient. Similarly, criterion sampling was used to select the student participants who have all experienced the course (Creswell, 2007) and shared the common status as non-majors, that is, none of them were biology majors. A combination of convenience and criterion sampling were used to obtain participants in the study.

The students in the qualitative component of the study were chosen using purposive sampling. The approximately equal numbers of male and female students in the focus groups were selected from the volunteers in the quantitative component of the study as “they can purposely inform an understanding of the research problem” (Creswell, 2007, p. 125).

Sample Characteristics

The co-ed students at Midwest Institute of Higher Education are national and international in origin, with most coming from within United States. The ages of the participants ranged from eighteen to twenty three years. The students were enrolled in a bachelor’s degree program of study, which typically takes four years to complete but in some instances requires five years. The sample included students who have declared academic majors within all four undergraduate colleges and schools excluding biology. This sample was referred to as non-majors. Most of the population lived on campus. All were English speaking.

Participants in this study were full-time students enrolled in the non-majors’ General Biology course in the fall of 2010 at Midwest Institute of Higher Education and faculty members in the College of Arts and Sciences. The study was conducted in the spring of 2011 in the one semester general education biology course for non-majors. Typical enrollment in the non-majors biology course is140 students. The list of student names was obtained from the registrar’s office.

Sample Size

In survey research, it is important to have the largest sample possible. According to Creswell (2005), though approximately 350 individuals are recommended for a survey, size varies due to several factors. In a nonprobability convenience sample where the population is limited, Creswell suggests selecting a sample as large as possible (p.359).

Typical enrollment is between 140 and 150 students per semester. The sample for the quantitative component of the study consisted of 145 male and female students using convenience/criterion sampling. This non-majors biology course is a one semester course.

The purposive student sample for the qualitative component of the study consisted of four focus groups nearly equal in gender from the eight laboratory sections for a total of 15 students. According to Creswell (2005) focus groups should consist of four to six individuals. Each groups had males and females represented. One group consisted of five students, one group consisted of four students and two groups consisted of three students for a total of eight males and seven females. The students were expected to attend only one focus group session.

Instrumentation

Standardized procedures through the course of the study ensure valid data gathering and analysis (Creswell, 2005). A survey was used in the quantitative component to measure students' perception of relevance of biology to everyday life. A second instrument was used in which students answered a yes/no survey regarding specific behaviors of the instructor as well as activities they participated in while in the course. In the qualitative component of the study, a third instrument was used in the form of focus group discussions with questions for participants on their experiences in the course. To reduce threats to the validity of the study, the Perception of Relevance Survey was not changed from pre to post-test.

Survey Instruments

Before and after participating in a higher education general biology course, students took a modified version of the Salish I Study (1997) Perception of Relevance Survey. The Salish I study was designed as part of a teacher preparation program in Iowa in 1996. The $1.72 million, forty month study involving ten institutions, new science and math teachers and results in science and math learning of students in new teacher classrooms (Salish II, 1998). Funded by the Department of Education, the Chautauqua for Improving Science Teacher Education Programs used the results of the Salish I study to provide information to nine higher education programs for science and math teacher preparation.

The Perception of Relevance Survey was used in 1997 to collect data on student perception of relevance of their science classes under the instruction of new teachers. Data from the study indicated that students perceive science classes to be more relevant than math classes. The study instrument is public domain and permission does not need to be obtained to use or modify it (Salish Research Consortium, 1997).

Modifications to the survey were made by the principal researcher for collection of data on a non-biology majors' course that has covered the cell-to-cell communication, genes and proteins, and patterns of inheritance. Changes to the survey were informed by current literature that reflects current issues in student interest in biology content. The survey questions were written by the principal investigator and were reviewed by a panel of experts to ensure content validity. A summary of the background and experience of each member of the panel of experts can be found in Appendix D.

A copy of the survey questions is shown in Appendix A. The survey contained 26 questions, divided into four parts, including (a) gender, (b) interest level in biology, (c) eight questions regarding student perception of relevance of cell-to-cell communication to their life, (d) eight questions regarding student perception of relevance of genes and proteins to their life, and (e) eight questions regarding student perception of relevance of patterns of inheritance to their life. A Likert scale was used for student responses to collect quantitative data.

At the end of the course, while the post-test was administered, students also took a survey on their experiences in the course. Students answered questions on a researcher developed yes/no survey with descriptors for specific methods of instruction utilized in higher education biology courses. The survey questions were written about lecturing and behaviors related to various methods of instruction defined by studies on cooperative learning by Slavin (1995), active learning teaching strategies by Freeman et al. (2007), problem-based learning by Waterman (1998), and inquiry-based learning Udovic et al. (2002). In the case of lecture, a dictionary definition was used (Rand McNally, 1973). The questions were reviewed by a panel of experts to ensure content validity. A summary of the background and experience of each member of the panel of experts can be found in Appendix D.

Focus Group Questions

The questions written for use in the focus groups reflected current studies (Hewlett, 2004; Freeman, 2008; Firooznia, 2006; Knight & Wood, 2005) that include relevance and current research on methods of instruction that affect student interest and engagement in biology courses. The questions addressed student experiences in the course with respect to the methods of instruction that were used in the course. The focus group discussion questions were written by the principal investigator and were reviewed by a panel of experts to ensure content validity as well as lack of bias in the wording. A copy of the questions can be found in Appendix B.

Data Collection Procedures

The study began once appropriate permission was obtained from the department chair, professors, and students at the university participating in the research. In the week before the course started, students were emailed a copy of the Letter of Informed Consent explaining the nature of the study, assurance of privacy, confidentiality, and request for volunteer participation. Students were informed that on the first day of class, they would receive a printed copy of the form that must be signed.

On the first day of the course, the principal researcher attended one of the sections of the General Biology course and greeted the students. In the first few minutes of the class, the researcher explained the nature of the study, assurance of privacy, confidentiality, and request for volunteer participation. Students agreeing to participate received a printed copy of the letter of informed consent. Instructions included student's prerogative to withdraw from the study for any reason for the duration of the study.

Once signed forms were collected, participating students were given the Perception of Relevance Survey for the cell-to-cell communication, genes and proteins, and patterns of inheritance. Students were instructed to follow the directions on the survey and not to place their name anywhere on the survey. After instructions were given and questions were answered, the investigator left the classroom. The instructor collected the surveys. This was repeated for the other section of the course. Once all surveys were collected, the instructor returned them to the investigator and the informed letters of consent were locked up for the duration of the study. When the chosen topics had been taught (approximately five weeks), the researcher returned to the class and requested that the Perception of Relevance Survey be completed by the participants again, followed by the researcher developed survey on student experiences in the course. The same procedure was followed with the investigator handing out surveys, leaving the room, and the instructor collecting and delivering completed surveys to the investigator.

Shortly after the completion of the last survey, focus groups were set up with the volunteer participants to collect information that is best yielded from the interaction of the interviewees (Creswell, 2005). Using the focus group model for qualitative data (Morgan, 1997) a purposive (purposeful) sample consisted of approximately even numbers of male and female volunteers. Four groups of participants were formed and volunteers were involved in discussions using semi-structured questions regarding opinions about the course and the methods of instruction used in delivery of the content. The focus groups discussions were recorded. Once transcribed, participants were given an opportunity to read the transcript of the focus group discussion in order to offer a second opportunity for clarification of comments (Kreuger & Casey, 2009).

Ethical Issues

It is critical in research that matters of consent, privacy and confidentiality of the sample population be guarded and protected (Creswell, 2005). Participants in this study were emailed regarding the nature of the study prior to beginning the course in which the study took place. The email list was generated by the roster for the course. Upon arriving to the first day of lecture, students were given a letter of informed consent. The letter of informed consent explained the study. It guaranteed participants their rights in the study, and upon signing, indicated agreement to volunteer involvement as well as their understanding of the protection of their rights (Creswell, 2005). In doing so, participants retained their autonomy and were able to judge for themselves the risks, though minimal in this study (Creswell, 2005). Participation was voluntary and those who agreed to complete the surveys or surveys and post-instruction interviews were free to withdraw involvement in the study if they so choose.

The signed forms were secured and will be locked up for seven years, at the end of which time they will be destroyed by burning them. Students were directed not to use their name on the survey or for the focus groups during the study, for the purposes of anonymity. No names appeared on the survey.

The 15 students participating in the focus groups had their real names recorded under pseudonyms to ensure anonymity. Auditory tapes of the interviews were secured during the study on a hard drive that only the principle investigator has the password to. The auditory files were kept for the duration of the study. No information about the participants was distributed to any other parties.

No participants received financial compensation for participation in this study. Students did not receive academic credit (extra credit) for participating in the study from this course or any other.

Data Analysis Procedures

Reliability of the survey was assessed using Cronbach's alpha. The quantitative data gathered from the adapted Salish I Study Survey was reported by using a 2 X 2 X 3 multifactorial analysis of variance (ANOVA). Pre and post survey scores were analyzed by topic and gender and evaluated for a three-way interaction. Using $p < .05$, significance was determined to reject the null hypotheses. Similar analysis was performed to determine if gender affects changes in perception of relevance.

Data from the Student Experience Survey questions consisting of yes/no only answers were analyzed for frequency of various methods of instruction that students may have experienced in the course. Descriptive statistics were used to organize and describe the characteristics of a collection of data and was used for analysis of the Student Experience Survey administered after participation in the course. Analysis determined if various methods were used and if so, was there a correlation between frequency of use of various methods of instruction and changes in perception of relevance.

The qualitative data was analyzed using a sequential thematic analysis (Percy & Kostere, 2008), in which the data collection processes were independent of the quantitative component and collected in separate phases (Creswell, 2003). By transcribing the sessions, the transcripts were read and color coded by themes into which the responses naturally created. The data was categorized using content analysis (Stewart, Shamdasani & Rook, 2007). Using a variation on a theme, the scissor and sort technique (Stewart et al., 2007) was used once focus groups discussions were completed. By combining responses of similar nature (similar color), themes emerged exposing insights about the methods of instruction under study. An interpretive analysis was performed using like responses to support similar themes. Confidence in the findings increased as multiple forms of inquiry exposed similar results (Kreuger & Casey, 2009).

The findings of the focus group discussion questions were summarized into themes. Each theme was defined by the responses of the participants during the focus groups. This data was used to add understanding of the findings of the quantitative Student Experiences Survey.

CHAPTER 4. DATA COLLECTION AND ANALYSIS

Introduction

The majority of students in higher education take a general biology course that, according to Francom, Bybee, Wolfersberger, & Merrill (2009) is not as rigorous as the biology course for biology majors. For non-biology majors, Marcus (1993) states that this may be the last science course students take for life. Students need to make connections between the sciences, as it helps them connect science to their personal world (Allen & Tanner, 2005). Literature on instruction in higher education identifies various methods that are used in biology courses designed for non-biology majors. Many are directed at increasing learning gains and improving interest. To prepare individuals for the demands of a rapidly changing culture, engaging with the content of the course is essential (Hohman, Adams, Taggart, Heinrich, & Hickman, 2006). Osborne et al. (2003) state that student interest in the sciences is a matter of perception of relevance.

The data and results of this mixed method study were used to evaluate the changes in perception of relevance in students having completed instruction in a higher education general biology course designed for non-biology majors. The changes were measured using three topics taught in a non-majors biology course at a small liberal arts college referred to as Midwest University. Pre and post scores, by topic were also evaluated by gender. In addition, the methods of instruction used in the course were evaluated by survey and focus group discussion to determine if there is a relationship between methods of instruction and changes in student perceptions of relevance of biology to everyday life.

Summary of Study

Midwest University

Midwest University is a four year liberal arts college which has been growing in enrollment for the last 12 years. With an enrollment of 4500 students, the student body is composed of primarily 18-24 year old students with a small percent of students over the traditional age. The ratio of females to males is 2:1.

Student Characteristics

Students are primarily American citizens, however other nationalities are represented. Students enrolled in biology-related majors offered at Midwest University are not required to take General Biology during their four year program. Midwest has a higher percentage of students in biology related fields than the national per capita for those in health care professions. This totals 710 students who are not required to take the course referenced in this study. All other majors are required to take the General Biology course. Table 1 shows the population from which the participants of this study were chosen.

Table 1

Enrollment Statistics for Midwest University

Total University Enrollment (spring 2011)	Biology/biology related majors	Non-biology majors	Percent of student body	Students enrolled in General Bio Spring 2011
4612	710	3902	85%	150 or 3.0% of candidates for Gen Bio

Research process

To conduct the study, 150 students were recruited from the General Biology course taught during the spring semester of 2011. Students elected to participate with no incentives offered and conveyed willingness by signing a letter of informed consent. The instrument used in the study was taken from the Perception of Relevance Survey created for use in the Salish I study in 1997 (Salish Research Consortium), as a part of an Iowa-based teacher education program. It was then modified to reflect the gender, interest level in biology of the participant, and the three topics covered in the general biology course. The survey was administered pre and post instruction in three topics taught in the course: cell-to-cell communication, genes and proteins, and patterns of inheritance.

Hypotheses and Research Questions

The Perception of Relevance Survey was administered pre and post instruction to address the hypotheses and research questions that follow:

Hypothesis1: There is a significant relationship between changes in students' perception of relevance of biology content to everyday life and gender after participating in a post-secondary non-major's biology course.

In addition, the collected data was utilized to address the following null hypothesis and answer the research question that follows regarding gender influence.

Null Hypothesis 1: There is no significant relationship between changes in students' perception of relevance of biology content to everyday life and gender after participating in a post-secondary non- major's biology course, Research Question 1: Is there a significant relationship between changes in students' perception of relevance of biology content to everyday life and gender after participating in a post-secondary non-major's biology course?

In addition to the Perception of Relevance Survey, a survey of student experiences was administered to identify methods of instruction used in the course. To provide insight on the Student Experience Survey, four focus groups convened and discussed their experiences in the course while the three topics were taught. The focus group responses, in conjunction with the Student Experience Survey, address the following hypotheses and research questions:

Hypothesis 2: There is a significant relationship between students' experiences with various methods of instruction in a non-major's biology course and students' perception of relevance of biology content to everyday life.

Null Hypothesis 2: There is no significant relationship between students' experiences with various methods of instruction in a non-major's biology course and students' perception of relevance of biology content to everyday life.

Research Question 2: Is there a significant relationship between students' experiences with various methods of instruction in a non-major's biology course and students' perception of relevance of biology content to everyday life?

The transcripts of the focus group discussion provided information and insight that were useful in addressing the following research questions:

Research Question 3. In what ways do student experiences with various methods of instruction used in the lecture and lab components of post-secondary biology affect student perception of relevance of biology content to everyday life?

Research Question 4. In what ways does gender affect changes in student perception of relevance of biology content to everyday life after participating in a post-secondary non-major's biology course?

Presentation of Data

The reliability of the survey questions were assessed by using Cronbach's alpha. Alpha is an indicator for internal consistency reliability (Gregory, 2011), a function of the number of questions on the survey and the average inter-correlation among them. The results from the Perception of Relevance Survey referred to from this point as the pre- and post-surveys are presented by using the ANOVA F test with $p < .05$ for significance. Data from the pre and post-tests were analyzed using the Predictive Analytics Software program, version 18.0, referred to as PASW from this point. Using a 2 X 2 X 3 multi-factorial ANOVA, as the study involved more than one factor or independent variable (Salkind, 2004). Results were measured between pre and post-survey scores, by topic, and gender for major effects and interactions within subjects. A two-way ANOVA addressed between subjects interactions for gender and pre post survey scores. Follow up tests were conducted for interactions for both ANOVAS to show the reliability and significance of the main effect, subsequent within subjects', and between subjects interactions. Focus group data are presented in a table of themes followed by a summary narrative. Participant comments with respect to each theme are presented, noting gender differences when evident.

Quantitative Data

To address the research questions of the study, two surveys were used. Data was gathered on students' perception of relevance pre and post topic instruction using a Likert scale. Data on student experiences during instruction were collected using a "yes – no" survey, where students responded to questions about their activities in the course.

Perception of Relevance Survey. The Perception of Relevance Survey was evaluated for internal consistency reliability using Cronbach's alpha.

Table 2

Perception of Relevance Internal Consistency Reliability

Topic	Cronbach's Alpha	N of Items
Cell-to-cell communication	.82	8
Genes and proteins	.86	8
Patterns of inheritance	.86	8

With a single variable being measured for internal consistency, the standard for acceptability is > 0.7 (George & Mallory, 2007). Each of the three topics in this study were analyzed for internal consistency reliability and all were found to be reliable with alpha scores of .8 or better, which are considered categorically "good" by George and Mallory (2007).

The Perception of Relevance Survey consisted of both positive and negative statements. Each statement was followed by a scale that consisted of "almost always", "often", "sometimes", "seldom", and "almost never". For positive statements, the "almost always" choice received a value of one point with each successive choice receiving more points, ending with "almost never" receiving the score of five. For negative statements, which consisted of the last two questions of each set of questions by topic, adjustments were made using PASW, and the value of each response was reversed, with "almost always" receiving five points with each successive response receiving fewer points, ending with "almost never" which received one point.

Table 3 shows the descriptive statistics for the pre and post Perception of Relevance Survey scores by topic and gender. The results indicate declines in mean scores for each topic and in each gender. Data also indicates a decline in the number of students that participated in the post test from the number of students that participated in the pretest.

TABLE 3

Descriptive Statistics for the Perception of Relevance Survey by Gender

Survey		Male		Female	
		Pre	Post	Pre	Post
Cell-to-cell Communication	Mean	31.08	27.51	32.05	29.85
	St Deviation	5.37	4.83	4.72	5.49
	N	37	35	59	47
Genes and Proteins	Mean	26.95	25.06	27.30	26.72
	St Deviation	6.81	6.11	6.37	6.32
	N	37	35	59	47
Patterns of Inheritance	Mean	26.16	25.17	25.88	25.17
	St Deviation	6.00	5.98	6.97	6.23
	N	37	35	59	47

The mean for each male pre survey of perception of relevance score by topic were less than the female means, except for in patterns of inheritance. The post survey means were also less for males than females, except for in patterns of inheritance, where they are identical. In addition, the difference between the mean for the male pre and post survey scores was greater than the mean for the female male pre and post survey scores for all three topics. The slight decline in the mean of pre and post surveys for genes and proteins as well as the mean of the pre and post surveys for patterns of inheritance, for both genders, is in contrast to the greater decline in means of the pre and post surveys for cell-to-cell communication for both genders. When observing the scores by gender closer, the decline in mean scores in the pre and post surveys for cell-to-cell communication was greater for males than females. The table also shows that the number of students taking the post survey fell in both genders, with the sharpest decline in females.

Table 4

Descriptive Statistics for Pre and Post Survey Results for all Participants

		Pre	Post	Mean
Cell-to-cell Communication	Mean	31.68	28.85	30.76
	St Deviation	4.97	5.32	5.31
	N	96	82	**178**
Genes and Proteins	Mean	27.17	26.01	26.63
	St Deviation	6.51	6.25	6.40
	N	96	82	**178**
Patterns of Inheritance	Mean	25.99	25.39	25.71
	St Deviation	6.58	6.09	6.35
	N	96	82	**178**

Note. Total participants in pre and post survey are in boldface.

Table 4 provides the data for all participants, regardless of gender, to reveal a within-subjects main effect for topics, p = .000, as shown in Table 5. Combinatorial pairwise testing was conducted to assess all possible relationships between topics.

Table 5 shows the results of ANOVA for one dependent variable and two independent variables. Using the statistical software package, PASW, the F test for ANOVA was used to determine a p value for within-subjects effects. The results present a one-way ANOVA by topic, a two-way ANOVA between topic and pre post survey, a two-way ANOVA between topic and gender, and one three-way ANOVA between topic, gender, and pre post survey.

Although the intent of the study was not to look for significant relationships other than those addressed by the hypotheses and research questions of the study, data indicates that other factors were involved in the changes of students' perception of relevance of biology to everyday life. Data also indicates that interaction of some of the factors have no significance in the changes in perception of relevance scores.

The p values using both Greenhouse Geisser and Huynh-Feldt, for the three-way ANOVA of topic, pre-post, and gender, resulted in p=.858 and .863, respectively. These findings indicate no significance for the three way interaction between topics, pre-post survey scores, and gender, therefore, the relationship between the three variables has no significance.

TABLE 5

ANOVA of Within-Subjects Effects

Source	Test	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Topic	Greenhouse-Geisser	1897.98	1.92	987.49	84.17	.000	.33
	Huynh-Feldt	1897.98	1.97	960.25	84.17	.000	.33
Topic* pre.post	Greenhouse-Geisser	113.59	1.92	59.10	5.04	.008	.03
	Huynh-Feldt	113.59	1.98	57.47	5.04	.007	.03
Topic* male.female	Greenhouse-Geisser	55.50	1.92	28.87	2.46	.089	.01
	Huynh-Feldt	55.50	1.98	28.08	2.46	.088	.01
Topic* pre.post* male.female	Greenhouse-Geisser	3.25	1.92	1.69	.14	.858	.00
	Huynh-Feldt	3.25	1.98	1.64	.14	.863	.00
Error (Topic)	Greenhouse-Geisser	3923.69	334.43	11.73			
	Huynh-Feldt	3923.69	343.92	11.41			

The two-way ANOVA for changes in scores based on topic and gender indicates marginal significance with a Greenhouse-Geisser and Huynh-Feldt of .089 and .088 respectively. Though related to Hypothesis 1, it does not address perception of relevance and gender. A subsequent two-way ANOVA for between subjects was conducted to address changes in perception of relevance pre and post survey scores and gender. The two-way ANOVA F test for within-subjects interactions between topic and pre-post survey scores indicates that the difference between pre and post survey scores is significant with $p = .008$ and .007, using Greenhouse-Geisser and Huynh-Feldt. Independent t tests were conducted to follow up on the effect of each topic.

The individual mean for the three topics' scores as shown in Table 4 were used to conduct independent t tests to follow up on significant interactions within topics and to determine specifically, where, if any, the differences exist. Table 6 shows the t-tests which disaggregate all three topics and reveals changes in topics scores that were significant and those that are not. The change in the pre-post survey score for cell-to-cell communication is significant with a p = .001, whereas the pre-post survey score changes for genes and proteins, p = .144, and patterns of inheritance, p = .564, are not significant. The data indicates that that main effect in the pre-post survey scores significance is due to the within subjects change in cell-to-cell communication, not the other two topics.

Table 6

Independent Samples t-test for Equality of Means

Topic	Equal variances	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference
Cell-to-cell	Assumed	3.51	194	.001	2.62	.75
Communication	Not assumed	3.50	182.92	.001	2.62	.75
Genes and	Assumed	1.47	192	.144	1.34	.92
Proteins	Not assumed	1.48	186.15	.142	1.34	.91
Patterns of	Assumed	.58	180	.564	.54	.94
Inheritance	Not assumed	.58	179.10	.561	.54	.93

The ANOVA shown in Table 5 also demonstrates that there is one main effect within subjects for topic with p = .000. To follow up on the main effect, combinatorial testing was conducted to determine if any relationships within topics were significantly stronger than others. The results of the pairwise comparison between cell-to-cell communication and genes and proteins is significant with p = .000; genes and proteins and patterns of inheritance is significant with p = .000; and cell-to-cell communication is significant with p = .016. Consequently, the p values indicate all relationships are equally significant.

A two way ANOVA was also conducted for between subjects' interactions between gender and pre post survey scores. Table 7 shows that there is not interaction between gender and pre post survey results.

Table 7

ANOVA of Between- Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Pre.post* male.female	13.19	1	13.19	.46	.50	.00

To determine if any one of the biology topics were less significant than another, independent t tests were conducted. Table eight shows the results of gender and cell-to-cell communication, genes and proteins, and patterns of inheritance.

Table 8

Independent t-tests for Gender and Pre Post Survey Scores by Topic

Topic	Type III Sum of Squares	df	Mean Square	F	Sig.
Cell-to-cell Communication	3.48	1	3.48	.130	.72
Genes and Proteins	10.04	1	10.04	.249	.62
Patterns of Inheritance	6.09	1	6.09	.151	.70

Table 8 p values exceed the allowable <.05 for the interaction between gender and each of the three topics to be significant. Consequently, none of the topics were any less significant than the other.

Student Experience Survey. The second quantitative component of the study was a student experiences survey given after the perception of relevance post-survey. Students, responding to a yes/no survey indicated the frequency of various methods of instruction experienced in the course while learning about the three topics. The mean of student responses per method were calculated by topic to determine if there is a relationship between changes in perception of relevance and frequency of the methods of instruction used in instruction.

Table 9 shows the results of the Student Experience Survey. The mean of student responses of "yes" are reported.

Table 9

Mean Frequency of Student "Yes" Responses for Methods of Instruction on Student Experience Survey

	Methods of Instruction				
	Lecture	Cooperative Learning	Active Learning Teaching Strategies	Problem-based Learning	Inquiry-based Learning
Cell-to-cell Communication	87	41	23.83	26	61
Genes and Proteins	76	36.2	20.3	22.67	54
Patterns of Inheritance	74	35.2	19	29.3	51.5
Total	237	112.4	63.13	77.97	166.50
Mean Frequency	79	37.47	21.04	25.99	55.5

To provide clarification on methods of instruction, brief descriptions that mirror the Student Experience Survey questions follow. While lecture is defined as the professor speaking to the class providing the content of the course, examples of cooperative learning include students being placed in groups, with individual jobs assigned to each student, where students are responsible for teaching the other members their component and are accountable for learning the other students' components, using collaborative skills like trust-building and conflict resolution. Active learning teaching strategies incorporate immediate assessment of student responses to questions posed in class with the use of personal response systems, activities such as think-pair-share, one-minute papers, and muddiest point opportunities for students to let the instructor know the point that students don't understand. Problem-based learning takes the form of case studies, in which students work in a group, assume the identity or role in solving a dilemma of biological nature. Inquiry-based learning involves laboratory opportunities, where students are given an opportunity to explore a topic, phenomenon, or collect data to find an explanation for a biological concept.

Lecture was reported with the greatest frequency, followed by inquiry-based learning. Cooperative learning ranked third, with problem-based learning and active learning teaching strategies following in declining frequencies. All topics followed the pattern of decreasing frequency; however, the frequency of lecture during cell-to-cell communication exceeds the frequencies by twelve and fourteen responses, of genes and proteins and patterns of inheritance respectively. Data from Table 8 provided the basis of discussion upon which the interpretation of the qualitative focus groups will develop.

Qualitative Data

Focus groups were convened during regularly scheduled lab sections. Participants were volunteers who also participated in taking the Perception of Relevance Survey. Groups had males and females represented in each group. One group consisted of five students, one group consisted of four students and two groups consisted of three students for a total of eight males and seven females. Conversation was very casual but followed a set of structured questions. Students seemed very sincere and showed genuine interest in desiring to help improve the course. Themes that emerged during the discussions will be presented in table form. A narrative will follow in which each theme will be explained and supported with specific comments made by the participants, identified by pseudonyms. The relationship between the focus group discussion responses and results from the survey of student experiences will be addressed. Gender differences will be noted when evident in the discussions.

When asked about the relevance of biology to life, students were quick to express how relevant they perceive biology to be. “I think it is very relevant because we, as humans, are biology and we change every day, I suspect. So, it’s probably very relevant”, is the opinion of Vince, one focus group member. Another member, Whitney, commented that, “I would say that yea; it’s pretty relevant because life is based on biology.” Other comments were, “If you understand the concepts beneath the surface, there are a lot of biological things in life” (Tim), “Everything you do is biology” (Barbara), and “I would confirm that without having any grounds to differ” (Kevin, the pre-law student). Students contributed to a group of themes during the discussions. The themes are listed below:

1. Topics relating to the human body are more relevant than other topics.
2. Professor's personal and instructional skills affect student engagement in the course.
3. Active engagement during instruction promotes understanding of relevance.
4. Laboratory exercises add an understanding of the relevance to the course.
5. There are other external factors that affect student engagement in biology courses.

Topics relating to the human body are more relevant than other topics. Students were asked if they thought some topics in biology were more relevant than others. Responses ranged from cells to ecosystems, but the greatest frequency of responses pertained to the human body. "I would say like the study of humans and stuff, cause that's what we are", commented Whitney. "Without understanding the chemical application as well, we really don't understand what our body is doing", added Kevin. "Understanding the cellular level, helps to understand how we get rid of a virus from our system", agreed Kyle. When Joanna mentioned the relevance of medicine, she immediately referenced the lab exercise that she had just completed on blood, stating that, "You could die if you didn't know things like the biology of your body and stuff." Josh referenced the same lab and stated, "Blood typing is very relevant, so we can give blood or [in the case of an injury], so that we can tell the doctor." Barbara added, "even if I'm not going to be a doctor, it's still pertinent to me [looking at blood under a microscope], it's part of my life."

With similar frequency, students brought up implications of knowing what the human body needs to remain healthy. Nikki commented, "I think that when you study nutrition and the effect of it to your body – eating healthy and exercising, just being able to see why it's important scientifically has been important to me." Kyle concurred that breaking up food into the four molecules was "cool" and gave him more application for nutrition. Antonio commented that learning about proteins "stood out more –about how your body absorbs proteins and how it helps in daily functions." Similarly, interest in disease prevention and cures were included. "Topics that involve diseases and cures are more relevant just because they save lives and just help people in general live longer and become healthier" is the opinion of Zach, echoing Kyle's interest in knowing how to rid one's body of a virus. Jude concurred stating that, "knowing about the human body is important so if we get sick, we can determine why."

The second biology topic of relevance that came up in discussion is the environment, beginning with the mention of the importance of plants. Kevin stated that, "Without plants, we wouldn't be here." Barbara brought up the environment, indicating that "learning about the environment benefits the world – people keep growing up without understanding and they make the same mistakes that people in the past have that hurts the world around us." Josh concurred about the importance of ecosystems.

The third biology topic identified is only referenced twice when students were questioned specifically about topics that were more relevant than others. "I'd have to say genetics is a huge thing in my mind, I think that's one of the main arenas that we're gonna find in the times to come – that's one of the majors in my mind", commented Alan. The second reference about genetics was by Heidi, a major in criminal justice, whose interest is in using DNA to solve crimes. The topic however, emerged many times during later questions in the focus group discussions. Genetics was brought up in all four groups when students were asked if the professor did anything in lecture or lab that made the content of the course seem more pertinent to life. Students from each of the four focus groups commented about a Punnett square activity used in lecture and lab. Three of the four groups indicated interest in knowing how to predict what characteristics potential offspring would have, based on the characteristics of the parents. Predicting what future offspring would be like elicited such comments as, "I thought it was interesting like how when you are going to have a kid – what could happen or what couldn't happen" from Heidi, and "that was a lot of fun and I had a good time and that really connects everyday life – it was very interesting to kind of predict what my kids might look like" from Josh. Jude added "I feel like it's important because it shows what our kids are going to be like, kind of portrays like the future with the Punnett square and all that."

Professor's personal and instructional skills affect student engagement in the course. When asked about the importance of the way in which content was delivered in class, students' responses fell into three general categories. Tim said of the instructor, "getting your point across is your job. Each teacher devises their own way." Though Jude commented simply, "each professor has a visual or auditory style", many of the participants commented with great frequency and detail on the instructor's personality, social skills, as well as their presentation and instructional skills.

While Joanna noted that instructors need to be knowledgeable in their field, student comments went beyond instructor competence in their field. Whitney began by stating that she has never been interested in science. "The only way that I'm interested is when I have like a strong teacher, who makes it interesting for me." Though the definition of strong was not made clear by her comment, other students' comments lent clarity to the theme. Hillary commented that having an instructor that is "passionate and excited about teaching a tough subject makes me more excited to know about it." Josh echoed her comment about effective instructors being passionate. Allen openly stated that instructors who are "engaging and lively make it easier to concentrate and learn. If just lackadaisical, sleepy sounding, it's not as easy to concentrate and learn."

Heidi pointed out that her lab instructor was enthusiastic, and made the course interesting telling students, "This is really cool because it does this or that."

Instructors who take a personal interest in their students' lives and share their own life stories demonstrate social skills that students find engaging. "If a teacher isn't connecting with students, the students aren't going to learn, no matter how important the topic is" Josh pointed out when discussing the importance of the qualities of the instructor. Heidi noted that, "I like it when the professor is really personal and seems like they want to know you." Nikki commented on her teacher in high school that was really good at trying to involve the class (by) asking questions about their personal lives, their day, their week – maybe just what they were feeling in that moment in more like a conversation way. During lecture he would refer back to that beginning conversation and it was just about our lives. Being able to relate those two really like connected." She also commented "It kind of makes you think that it isn't just about the classroom, it's about life." Providing personal stories is also important to students. Kevin pointed out how telling personal stories made things more pertinent. Josh remembered the lecture on cell-to-cell communication, when the instructor talked about his nephew who had just had a spinal cord injury. "That memory stood out as a personal example, so that's how he really connected the material." Allen added that a sense of humor is a "really great teaching tool", indicating that "a lot of people relate well to that and are more likely to remember – and talk about it later."

Instructors' presentation and instructional skills also affect student engagement. Kyle referred to this as the "most important aspect to teaching, because if you don't engage the students, everything else is a lost cause." Cassie commented several times about the importance of the volume of the instructor's voice as well as the range of tone, stating that instructors that are "monotone and talking so low and you can't really hear makes it boring". Good communication skills were referred to with multiple students commenting on the importance of the ability to "word things in a way students understand, using language that helps students focus on content. The way an instructor words things can be a distraction – the *way* he is talking about it (the topic), is what I'm thinking about, not the content" mentioned Barbara. Kevin added that staying on track with the content is important to retaining student interest and added, it's "tough to get anything out of lecture when information is taught in a spastic way."

Being organized helps students focus on important points. Antonio commented that “if it’s all just straight lecture, I find it boring.” Other students also expressed a preference for the instructors “to switch things up a bit”, as Kyle put it. “I’m not saying group projects, but maybe a video or something that would give us some feedback”, commented Antonio. Nikki, an education major wants an instructor to do things to make it interesting for students, providing examples and [PowerPoint] slides with explanations. Allen and Barbara, who identified themselves as visual learners, like it when instructors use PowerPoint. Hillary is more interested when instructors give real life examples. Nikki agreed that it’s “more real with real life examples.” Zach, Tim, and Jude commented that instructors that use analogies, mnemonic devices and word games “help connect to the content – to easily [help you] remember what you are being taught.” Nikki pointed out that she was motivated by the instructor who challenged her to find biology “in the weekend.” Student comments that conveyed a desire for more active participation lead to the following theme.

Active engagement during instruction promotes understanding of relevance.

Participants made several comments about classes consisting of exclusive lecture. “If it’s all just straight lectures, I find it boring” commented Antonio. “Lecture does not get students involved” added Kyle. He also indicated that professors who “switch things up a bit, so he has attention” get student’s attention. Antonio stated that instructors need to do, “something to get us some feedback”. According to participants, student involvement is pivotal to promoting an understanding of relevance.

Participant comments listed characteristics of engaging class activities to include the subtle use of real life examples and analogies in lecture. Allen referred to them as “something they [students] can recognize – if you can relate it to life then that’s a lot more applicable.” Nikki needs examples, “especially for biology.” Hillary said, “Real life examples about how this can affect our everyday lives – that always helps me.” Zach suggested that with a subject that student isn’t very knowledgeable about; “it’s helpful to have the teacher use examples outside of the subject or analogies – another way that it could relate to the student.” Challenging students to find what parts of campus are analogous to the parts of the cell, was referred to by several students. Another commented on liking being challenged to find biology outside the classroom on the weekend.

Heidi supports opportunities to get involved in class, like “turning to a classmate and discussing questions in class is good - as long as the answer is eventually given by the professor”. In addition, members repeatedly indicated a desire to interact with the professor, with question and answer sessions at the end of class and sessions outside of class. Nikki feels that, “sometimes you just need to clarify stuff”, though feels like she is interrupting during lecture if she raises her hand. Barbara expressed the desire to discuss course readings. Though, not during the formal instruction of the course, Zach and Nikki suggested a regular weekly supplemental course session.

Participants also indicate a desire to conduct activities that apply to them immediately, like finding their position using a GPS. Every focus group commented on investigations that apply to their future, citing a Punnett square activity. The exercise was used to help students see what their future offspring would look like. Students worked together in groups of 4 to find out the characteristics of potential offspring. Heidi commented, “I thought it was interesting because when you are going to have a kid, different things affect them in different ways.” Antonio commented that “it’s an amazing thing – to have a blueprint of what the child would be before you even see the child.” Hillary agreed stating, “I learn best from doing hands on, hearing other people talk about their experiences – like when we were figuring out what our kids would be like.”

Students also find that mnemonic devices and word games help to expedite learning. One component of the course that allows student involvement is the laboratory, where students spend two hours each week.

Laboratory exercises add an understanding of the relevance to the course. The laboratory experience for General Biology is two hours per week, approximately the same length of time students spend in lecture. Student comments were very pointed with respect to what learning and application took place in lab, often referring to it as pivotal to understanding the relevance of the course. Kevin stated, “I think labs are great and where I learned the majority of what I’m learning in the course.” Whitney echoed Kevin’s sentiment stating “I understood it more in lab then I did in lecture.” Barbara commented, “I guess, even though I am not going to be a doctor it is still pertinent to me because it’s part of my life and I enjoy it. Because I am doing it [the lab] is why I enjoy it. I guess that’s it, it makes it real.” Whitney stated that lab is responsible for “showing how the information relates to life.” Jude summarized it all with, “I think lab is a huge part of Gen Bio.”

Representing a different learning environment, Whitney added that compared to memorizing facts in lecture, in lab, it's "how does this relate to life?" Hillary added, "I learn best from hands on and things like that, so, in class exercises or the labs." Antonio indicated, "I think my lab is way more interactive, but I guess the lab is supposed to be more interactive, but I am more enthused in lab." "Just since it got us more involved, I would say I remembered it more" Zach added. Barbara concurred that, "it is much easier for me to understand the content when you are involved in it" and added, "the labs stuck with me, not just looking at it, it is easier."

Participant comments regarding relevance involved labs working with a range of topics. Tim commented that, "in lab we were able to see specifically how that all ties into life - learning about all the different actions and responsibilities of the cells and what they do for each of our bodies." Joanna commented, "in lab today, we were working with blood type, it's just important." Josh added, "blood typing – that's very relevant." Nikki added that, "lab was definitely more, something I remembered because it was things that related to who we are and our parents - they really are important to who [sic] we are and our kids will have patterns that we have, that was cool to think about that." Antonio, the only African-American male, commented on a lab activity where genetic traits were discussed. His reference was to the gene for sickle cell anemia, with respect to being compatible with a woman for having children.

There were no comments made about dissatisfaction with lab activities or the time required. One student's comment about lab indicated that it needed to be synchronized better with the lecture component of the course; however, participant comments about the importance of lab to their understanding of relevance were well thought out and made a point of the significance of lab.

There are other external factors that affect student engagement in biology courses. When given an opportunity, students listed other components of the course that affect engagement. Kyle noted that the size of the lecture hall makes it difficult to try group activities. Cassie commented that, with little room to write or draw on boards, "the room isn't really that fitting for biology." Kevin commented that "the room is so dark." "It needs more energy", added Kyle. The length of the class is a limiting factor for some students who would like to have time to ask questions. Josh was quick to calculate that if, "we have 5 minutes for questions, that's 10 percent of the class, and that's 10% of the content we don't get to", admitting that he didn't have an answer to the question and answer dilemma. Students also commented on the lack of understanding and loss of knowledge by "just memorizing." Whitney summarized her experience as, "so, it's more of just - this is the information you need to memorize for the test in lecture, but in lab, it's how does this relate to life? I really didn't have much of a clue." Kyle commented that "all that information will fade away." Kevin added "I remember the PowerPoint, I remember being at the lecture, and I remember studying for the tests, but that's where I got most of my information which has all gone away."

Students having enough time to complete exercises in class was a reoccurring issue. Whitney commented on not understanding directions about an activity and feeling rushed to turn it in, "and it was just so much focus on that [turning it in] that, it kind of took some of the relevancy away." Kyle recalled this happening in another class, stating, “it was kind of hectic and a little confusing.” Students experience the same time crunch with taking notes, Nikki commented, “You maybe didn’t get all the notes down and you’re worried about getting all the notes down and you don’t even really comprehend what you are hearing.”

Though the original intent of the study was to identify what instructional methods affected students’ perception of relevance of biology to everyday life, the focus group discussions revealed a great deal more information. Topics that are more relevant to students, attributes of the professor, the significance of laboratory exercises and other external factors were revealed in the study in addition to the role of active engagement during instruction and its effect on students’ perception of relevance of biology to everyday life.

Gender did not play a significant role in student responses. Student comments on the most relevant topics were generated by both genders with nearly equal frequency. Eight males participated in the study, while only six females participated. The average number of comments made by males was 9. Females registered 10.7 comments each. Each theme was generated by similar frequency of responses by gender.

One difference did become apparent in the area of student expression of interest in science. Several comments were made reflecting a lack of interest in science or difficulty in studying it. The common thread between the four comments is that they were all made by females. Hillary commented that she “didn’t necessarily like to study it”, whereas Nikki felt, “it isn’t the easiest thing to study.” Heidi said that, “It’s relevant, but on a day to day basis, I personally don’t think about it or make time to study it.” And although Barbara spoke of biology being a part of your everyday life, “ideally, we should be reading all these journals [about the human body] but every person isn’t going to do that. It’s important, yes, but do we care all that much? Unfortunately, no.” No comments of this sort were made by males in any of the focus groups.

Data Analysis

In this section, the results of both the quantitative and qualitative data are disaggregated and reorganized in reference to individual hypotheses and research questions. The results focus on the hypotheses and research questions. Data convergence informs the understanding of the relationships that exist between gender, methods of instruction, and students’ perception of relevance of biology to everyday life. The Perception of Relevance Survey and focus group discussions are used to address Hypothesis I and Research question 1.

Hypothesis 1 and Research question 1 are addressed with the data gathered from the pre and post Perception of Relevance Survey and the focus group discussions.

Hypothesis 1: There is a significant relationship between changes in students’ perception of relevance of biology content to everyday life and gender after participating in a post-secondary non-major’s biology course.

Null Hypothesis 1 There is no significant relationship between changes in students’ perception of relevance of biology content to everyday life and gender after participating in a post-secondary non- major’s biology course.

Research Question 1: Is there a significant relationship between changes in students' perception of relevance of biology content to everyday life and gender after participating in a post-secondary non-major's biology course?

The hypothesis is specifically written to determine the relationship between changes in perception of relevance and gender. Because perception of relevance was evaluated using three topics: cell-to-cell communication, genes and proteins, and patterns of inheritance, ANOVA was used to determine the significance of the changes in pre and post scores for perception of relevance by topic as well as by gender. Follow up t tests were conducted to identify significance by topic.

The results from the two-way ANOVA, shown in table 7, indicate no significance for the pre and post survey scores by gender with $p = .497$. Consequently, independent t tests were performed by topic. Table 8 shows the results of the t tests indicating that after participating in a higher education non-biology major's course, there is no significant relationship between changes in students' perception of relevance of biology content to everyday life and gender for cell-to-cell communication (F, 1(192) = .130, p=.719). In addition, there is no significant relationship between changes in students' perception of relevance of biology content to everyday life and gender for relationship between changes in perception of relevance and gender for genes and proteins ($F(1, 190) = .249$, $p=.618$). Consistent with the results from cell-to-cell communication and genes and protein survey scores, there is no significant relationship between changes in students' perception of relevance of biology content to everyday life and gender for patterns of inheritance (F(1,(178) = .151, p = .698).

Focus groups, led by qualitative generic inquiry reinforced the results of the quantitative analysis. Both genders spoke during the focus groups, neither gender dominated the discussions. Tim commented that, "there's always going to be some sort of science wrapped up in eating, walking, studying, and working" conveying the sentiments of Jude and Barbara, other group members. Nikki commented on "eating healthy and exercising", also brought up by Antonio from another focus group. Joanna mentioned the relevance of medicine for saving lives, while Zach commented, "topics like diseases and cures are more relevant just because they save lives." Comments about the environment were initiated by Kevin and Barbara. Comments on genetics and future offspring were also contributed by both genders. Nikki and Josh shared interest in the possibilities for future children. Nikki commented, "Our kids will have the patterns that we have. That was cool." Josh added that it was, "a lot of fun, it was interesting to predict what my kids will look like."

No gender differences appeared in the biology topics that participants identified as more relevant, the role of active engagement in promoting perception of relevance, how laboratory exercises effect perception of relevance, or the frequency of comments made by each gender in the focus group discussions. Each male commented an average of 9 times, while each female spoke 10.7 times. In this study, data confirmed that there is no significance in the relationship between perception of relevance and gender.

The Student Experience Survey and the transcripts of the focus group discussions provide information and insight in addressing Hypothesis 2 and Research question 2.

Hypothesis 2. There is a significant relationship between students' experiences with various methods of instruction in a non-major's biology course and students' perception of relevance of biology content to everyday life.

Null Hypothesis 2. There is no significant relationship between students' experiences with various methods of instruction in a non-major's biology course and students' perception of relevance of biology content to everyday life.

Research Question 2: In what ways do student experiences with various methods of instruction used in the lecture and lab components of post-secondary biology affect student perception of relevance of biology content to everyday life?

Quantitative scores for each topic were obtained from the Student Experience Survey. Student responses of *"yes"* to questions regarding experiences in the course that were coded for specific methods of instruction were added. These totals were then divided by the number of questions used for each method, which varied. Table 7 shows the mean frequencies for methods of instruction used in the course.

In the survey, lecturing is represented with one question. Students responded with the greatest frequency to being asked if they experienced, "the professor speaking to the class providing the content of the class." Students also indicated with a significant drop of more than twenty "yes" responses, in each of the three topics, for experiences with inquiry-based learning. These two methods are the most commented on in the focus group discussions. With students referring to lecturing as "boring" and not "engaging", it is worth considering what the effect lecturing has on students' interest in biology as well as their perception of relevance. Participants in the focus groups commented next on frequency inquiry-based learning in the form of laboratory experiences. These comments were from a different perspective than lecturing. Student comments about lab referred it as Whitney stated, "Where they try to tie everything into how we live." Kevin concurred with, "I think labs are great." The next method of instruction, cooperative learning, dropped by fifteen responses for each topic, followed by problem-based learning and last, active learning teaching strategies.

The pre and post score survey means indicate a decrease in perception of relevance. According to Smith, Sheppard, Johnson, & Johnson (1977) large class lectures are often remiss in motivating students to participate in meaningful intellectual engagement. Focus group participants concurred. Kyle commented, "It's hard in a lecture hall that big", "and dark" Kevin added, "and gloomy" droned Cassie. Lord and Baviska (2007), state that introductory biology classes are reduced to classic memorizing and recalling experiences, which according to Whitney, a focus group participant, "is what lecture is all about". Kyle added it "does not get us involved". It is reasonable to connect the drop in perception of relevance and use of straight lecture. Cooperative learning, though large enrollments make it difficult (Carmichael, 2009) shows improved learning gains over traditional methods (Lord, 1998: Varma-Nelson, 2006). Though gender bias in favor of males is reported by Kahle and Meece (2004), it is not evident in this study, as female scores dropped less than male scores for perception of relevance in two of the three. Table 3 shows that females' scores were higher than males in each topic, pre and post, and the decrease in perception of relevance for males was 2.15, while the decrease for females was 1.05. Female perception of relevance declined the least.

Research Question 3: In what ways does gender affect changes in student perception of relevance of biology content to everyday life after participating in a post-secondary non-major's biology course?

Gender did not affect student perception of relevance as determined by the two-way ANOVA for the effects of gender on pre and post Perception of Relevance Survey scores. Table 5 shows the significance of .089 and .088 for Greenhouse-Geissner and Huynh-Feldt. Likewise, it was not evident in the focus group discussions that gender plays a role in perception of relevance.

Research Question 4: Is there a significant relationship between students' experiences with various methods of instruction in a non-major's biology course and students' perception of relevance of biology content to everyday life?

According to the results of the Perception of Relevance Survey, perception of relevance declined after participating in a higher education non-major biology course. Focus group discussions can provide rich data to explain this and other phenomenon (Kreuger & Casey, 2009). In light of the data from the Student Experience Survey and the focus group discussions, student experiences are not measuring up to their preferred experiences in a biology course. Students commented repeatedly about lecture, which concurs with the Student Experience Survey data. The relationship of lecture to perception of relevance indicates that lecture could have a negative effect on perception of relevance.

Students also commented with great regularity about lab and hands on experiences, indicative of inquiry-based learning, where they were able to connect with the information and see its application. Participants enjoy the hands on experiences and figuring things out. Hillary stated, “I learn best from hands on and things like that, so, in class exercises or the labs.” Tim responded with “how that all ties into life.” Students indicated that they learned more and made more connections when they asked questions and explored the content in a lab setting. Table 9 shows that inquiry-based learning ranked second in frequency as reported by students. Students enjoy being able to figure things out and apply them to their own personal future. By sharp decline, cooperative learning ranked third in frequency of student experiences. Only one instance was referred to having occurred in lecture. Cooperative learning, as referred to by students, occurred during their lab in which they were assigned to groups, with the exception of one genetics exercise in lecture. Student responses for problem-based learning were next in rank, but did not mention problem-based learning or associated case studies in the focus group discussions. Though the frequency of active learning teaching strategies was the least of all the instructional methods reported on the Student Experience Survey, one focus group participant, Whitney, made reference to “turning to your neighbor to ask a question.”

Though not a part of questions on the the Student Experience Survey, students lent a great deal of insight about the significance of the relationship between the other methods of instruction and activities during the course and perception of relevance. In an opposite finding study, it is prudent to examine what did and did not occur in the lecture and lab, and what students are suggesting to make the course more relevant. Students commented that the ways that the instructor made applications to everyday life were some of the most engaging things that occurred in lecture. When asked what students would like to see in the course, responses were overwhelming for interaction with the professor, application of the material, and how to use it in life. In discussion, participants noted an absence of the activities mentioned above. Students also provided a list of topics that they perceived as more relevant than others. The three topics chosen for the study were not on the list.

In response to research questions 4, it is reasonable to say that there is a significant relationship between students' experiences with various methods of instruction in a non-major's biology course and students' perception of relevance of biology content to everyday life.

Summary of Findings

This chapter has summarized the findings of this mixed method study utilizing surveys and focus group discussions to gain a better understanding of the relationship between students' perception of relevance and the methods of instruction used in a biology course for non-biology majors. Quantitative data were collected in surveys and analyzed using ANOVA and follow-up t tests. Qualitative data from focus group discussions provided rich input regarding what biology topics students are interested in and preferred methods of instruction. Students also lent input on engaging professor personal characteristics and social skills as well as classroom design. The data presents a bricolage of higher education general biology course content and method of instruction that students perceive as essential for an engaging course. Chapter 5 will present a summary, conclusion of results, and considerations and recommendations based on the findings of the mixed method study.

CHAPTER 5. RESULTS, CONCLUSIONS, AND RECOMMENDATIONS

Introduction

This final chapter is designed to provide the key components of the study, by summarizing highlights from Chapters 1, 2, and 3 and discussing the conclusions based on the findings as they inform the research hypotheses and research questions. Analysis of the methodology and results, as well as a comparison between findings of the study and what is reported in current literature about perception of relevance, methods of instruction, and gender is included. Recommendations for practice and future research, as well as implications of the study are provided with respect to previous studies about student engagement and perception of relevance.

Summary of the Study

As a part of higher education general education requirements non-biology majors are required to take at least one semester of biology. Typically known as general biology, the course is not as rigorous (Francom, Bybee, Wolfersberger, Merrill, 2009) as biology for majors. According to Marcus (1993), this may be the last biology course ever taken by the ninety percent of the population that do not go into biology related fields. With large enrollment classes, student intellectual engagement is compromised (Smith, Sheppard, Johnson, & Johnson, 2005). Historically, the number of women entering the field of science has been increasing, and though more are obtaining doctorates in STEM fields, the "leaking pipeline" illustrates the impact of gender bias and its role in women's attrition in the field of science and careers starting with high school (Cleaves, 2005).

Changing enrollment in biology courses reflect that introductory science courses are discouraging science majors by weeding out weaker students (Sorensen, 2000). In accordance with the National Science Education Standards (National Research Council, 1996), to prepare all citizens to be scientifically literate and effective life-long contributors to society, effective biology instruction is pivotal in the preparation of students today (Osborne, Drive, & Simon, 1998). Various models of instructional design have been developed to improve student interest, increase measurable learning, and to alter didactic instruction in higher education (Lord, 1998; Udovic, Morris, Dickman, Postlethwait, & Wetherwax, 2002). Though perception of relevance plays a significant role in student interest (Osborne, Simon, & Collins, 2003), little is known about how and to what extent various methods of instruction affect students' perception of relevance of biology to everyday life.

A study of the literature on methods of instruction discloses an evolution of strategies reflecting the theory of social constructivism. Students show an increase in learning more by doing something active rather than traditional passive ways (McKeachie, 2002). According to Hammond (1997), engagement in genuine action and personally relevant activities, provides students opportunities to use real experience to test preconceptions and misconceptions which also improves students' communication skills with new technologies. Von Glasersfeld's (1987) work states that physical experiences are one way in which individuals make sense of their world.

Social constructivist methods of instruction include active learning teaching strategies (Freeman, 2007), problem-based learning (Sungur, Tekkaya, & Geban, 2006) and the use of case studies (Waterman, 1998), laboratory courses (Cavanagh, 2007), and cooperative learning (Slavin, 1995). Though constructivism is the preeminent learning theory upon which most science instruction is based, opinions range regarding how knowledge construction occurs (Palmer, 2005). Evaluation of various methods of instruction has been reported in measureable learning outcomes and interest in biology (Freeman, 2007); however, no literature exists on the effect of methods of instruction on the perception of relevance of biology to everyday life in non-biology major courses.

Students were recruited from the general biology course at Midwest University. 145 students were asked to participate in the study. Students read and submitted signed letters of consent prior to participating in the study. Quantitative data was collected in two surveys. The Perception of Relevance Survey was taken by the participants, pre and post instruction in three topics: cell-to-cell communication, genes and proteins, and patterns of inheritance. The second quantitative survey, the Student Experience Survey, was given once instruction over the three topics was complete. Qualitative data was collected using generic qualitative inquiry in focus groups.

ANOVA and independent t tests were conducted using the data from the Perception of Relevance Survey to determine descriptive statistics, main effects, and interactions between subjects. Descriptive statistics were used to represent the mean frequency of methods of instruction from the Student Experience Survey. Sequential thematic analysis was used to identify themes that emerged during the focus group discussions.

Summary of Findings and Conclusions

The study's focus was on student responses to methods of instruction indicated by changes in the Perception of Relevance Survey and focus group discussions. Gender analysis was included in the Perception of Relevance Survey. Implications of the findings of the study were used to draw conclusions relative to each research question and hypothesis.

Hypothesis 1

There is a significant relationship between changes in students' perception of relevance of biology content to everyday life and gender after participating in a post-secondary non-major's biology course.

Null Hypothesis 1

There is no significant relationship between changes in students' perception of relevance of biology content to everyday life and gender after participating in a post-secondary non- major's biology course.

Research Question 1

Is there a significant relationship between changes in students' perception of relevance of biology content to everyday life and gender after participating in a post-secondary non-major's biology course?

Table 5 shows the two-way within subjects ANOVA for gender and topic. The p values for the interaction between gender and topics were .089 and .088 according to Greenhouse-Geisser and Huynh-Feldt, respectively. Independent t tests were conducted by topic, confirming that for each topic, $p > .05$. In an additional two way between subjects ANOVA shown in Table 7, the p value for interaction between gender and pre and post survey scores was .497. Follow up t tests showed that for cell-to-cell communication p = .719, for genes and proteins p = .618, and for patterns of inheritance p = .698. Each p value exceeds that acceptable p< .05 for there to be a significant interaction between each and gender. Consequently, the null cannot be rejected.

Further analysis of the methodology of the study gives insight to the results of the study. Because the course is taught to non-biology majors, it is possible that the limited interest in biology is shared equally by both genders. ACT scores were not requested at the time of data gathering to know the experience and aptitude / level in biology of each student. Students may in fact not only share a lack of interest in biology, but also share a common lack of aptitude for the necessary rigor of the course. Though current research indicates that more females are entering science, technology, engineering, and mathematics (STEM) fields, the population from which the participants of this study were chosen (non-biology majors) is not likely to enter STEM fields. The population from which this study draws its data includes females that Seymour and Hewitt (1997), propose to have experienced lower expectations in secondary education, creating a trajectory in career interest away from biology. It is possible that the females that have entered higher education as non-biology majors have no less interest than the males who have also chosen not to go into biology related fields, as the gender bias has already had its effect prior to major selection. Another possible explanation for the lack of gender bias demonstrated in the data of the study is that the survey questions are not written to detect gender differences. One other explanation lies in the methods of instruction used in the course, which included cooperative learning, problem based learning, active learning teaching strategies, and inquiry based learning, where according to Kahle (1990), diffuse the effects of whole class activities, where males typically dominate. Consequently, the data reflecting the changes in perception of relevance scores by gender may not accurately represent data for the entire population of higher education males and females. While gender is a factor in interest and career choices in STEM related fields, the results of this study did not reflect expected gender bias in the collection of data on perception of relevance. Gender bias did not seem obvious in the focus group frequency of responses or the creation of the list of topics that are more relevant to higher education students in non-biology courses.

Hypothesis 2

There is a significant relationship between students' experiences with various methods of instruction in a non-major's biology course and students' perception of relevance of biology content to everyday life.

Null Hypothesis 2

There is no significant relationship between students' experiences with various methods of instruction in a non-major's biology course and students' perception of relevance of biology content to everyday life.

Research Question 2

Is there a significant relationship between students' experiences with various methods of instruction in a non-major's biology course and students' perception of relevance of biology content to everyday life?

Data from the Student Experience Survey served to determine the primary modes of instruction used in the biology course under study, as well as a quantitative measure of the frequency of occurrence based on student responses. The data was used for reference purposes to elucidate the relative amount of experiences students had with each method. Using the quantitative data from the Student Experience Survey, supported by the qualitative data from the focus group discussions, the data provides reason to reject the null in favor of the alternative hypothesis, meaning that there is a significant relationship between students' experiences with various methods of instruction in a non-major's biology course and students' perception of relevance of biology content to everyday life.

Though the perception of relevance decreased in the study, analyzing the methodology of the study may provide some insight to the drop in scores. It is possible that the second Perception of Relevance Survey was administered too late in the study. While five weeks is not a long time in a general biology course, it is possible that students may experience a drop in interest the longer the wait between instruction and assessment. It is also possible that students forgot the content in the period of time from instruction to the administration of the second Perception of Relevance Survey. Focus group discussions illuminated possible causation for such opposite findings. Students indicated a desire for active engagement in the course as well as a professor that takes an interest in their lives, topics that are more relevant to their world, laboratory exercises to reinforce what they are learning in the course and a learning environment conducive to discussion when students felt necessary. While without these components in place, it is understandable that perception of relevance will not change, it is also possible for perception of relevance to decrease when students get discouraged with the quantity of content to master and not feeling any connection to the course. This phenomenon is supported by the work of Smith, Sheppard, Johnson, & Johnson (2005), who claim that classes in large lecture halls and using lecture are not successful in intellectually engaging students. Constructivist methodology advocates that new learning can be built on old experiences. With students focused on activities that promote engagement, like laboratories that are based on previous knowledge, students are able to make sense of their world. Student requests for more interaction also reinforces Freeman et al.'s (2007) success with active learning teaching strategies. Frequent student comments during the focus group discussions, about what content they remembered due to active engagement or instructor examples based on prior knowledge, or personal experience reinforces Vygotsky's tenets of Social Constructivism (1978). Consequently, the null hypothesis was rejected in favor of the alternative hypothesis, indicating that methods of instruction do have a significant effect on students' perception of relevance of biology content to everyday life.

The qualitative part of this study addressed the following research questions:

Research Question 3

In what ways do student experiences with various methods of instruction used in the lecture and lab components of post-secondary biology affect student perception of relevance of biology content to everyday life?

Students were affected by methods of instruction, their level of interest in the course content, their ability to see application of the content, and the ability to make connections between the content and their everyday lives. When the instructor related personal stories and examples, students were more interested in the content. Students indicated positive responses and spoke of the effectiveness of using every day practical examples during lecture. This finding indicates that it would be worthwhile using case studies, a type of problem-based learning, to engage students. This is supported by Herreid's (2008) work in which he states that case studies motivate students to research information and develop analytical skills (Udovic et al. 2002; Waterman, 1998). In the process of investigating to understand the facts, values and decisions have to be made. In this context, students begin to make connections to their own lives, in which relevance becomes pertinent.

Students also expressed a desire for more active learning teaching strategies in several ways. Interactive instruction between student and instructor, for clarification of the content, is preferred over pure lecture. According to Freeman's (2007) work, measurable results were even more positively pronounced when students were given points for their participation. Students commented on working on questions with other students during lecture where the answer was eventually given would be an improvement over straight lecture. Participants in the focus group discussions frequently commented positively about being able to interact with lab instructors as well. In addition, students identify "hands on" inquiry-based learning in lab as pivotal to their ability to "pull things together". Participants also stated that lab helps them relate science to everyday life.

The study revealed other factors that affect students' perception of relevance. Topics related to the human body, the environment and DNA are of more interest and students find these topics are more practical in nature. Students are also affected by the personality and instructional abilities of the professor, as well as external factors such as the lighting and temperature of the room. While relevance is mentioned in Hohman's (2006) work, neither the abilities of the professor, nor the external factors such as the lighting and temperature of the classroom are found specifically in literature. The results of this study have shown that these components are pivotal to the success of an instructor whose intent is to help students master the content and thought processes inherent in a general biology course for non-biology majors, while seeking to convey the content as relevant to everyday life.

Research Question 4

In what way does gender affect changes in student perception of relevance of biology content to everyday life after participating in a post-secondary non-major's biology course?

The separate two-way between subjects ANOVA shown in Table 8 between pre and post survey scores by gender indicated that there is no significant interaction between gender and perception of relevance. Independent t tests by topic were conducted and indicate that there is no significant relationship between changes in students' perception of relevance of biology content to everyday life and gender for cell-to-cell communication, genes and proteins, or for patterns of inheritance. In addition, gender did not seem to affect participation in focus group discussions. The frequency of participation in the focus groups was nearly equal with the mean of male comments for all 4 groups was at 9 and the mean of female comments for all 4 groups was 10.7. The list of topics of more relevance was generated by both genders. Comments made about the human body, its health, reproduction, and defense from disease, the environment, and DNA was contributed by both genders. No single gender was responsible for a topic. Interest was shared. To capture any difference by gender in future studies, gender specific groups could be formed and lead through the questions. Rich data could be obtained to better reflect the effect of gender on student responses. The results of this study have fostered more questions on perception of relevance, gender, non-biology majors, and perhaps a threshold of motivation that affects perception of relevance by gender.

Gender differences were only apparent with reference to comments made by four females regarding the difficulty of learning and studying biology as well as lack of interest, whose causation reveals yet another possible area of study not addressed by this research. Consequently, with a p value of 0.719, with separate t tests indicating no interaction with significance by topic, similar frequency of comments during the focus group discussions, and participation of both genders in the creation of the topics of greatest relevance, gender does not seem to affect students' perception of relevance of biology content to everyday life after participating in a post-secondary non-major's biology course for this population. According to Weisgram and Bigler (2007), females that are aware of gender discrimination as adolescents tend to see past negative experiences and do not question their ability, but rather see past discrimination. With self efficacy improved, females improve their belief that science is worthwhile to study. In this study, it is not apparent that the females demonstrate evidence of instruction on discrimination during adolescence, but rather espouse their disinterest as well as a lack of ability to see the study of science as worthwhile.

Perhaps yet another way to identify gender specific topics would be to repeat this study in bio-major's courses, where students may have a greater interest and have already begun to think about what their job or career is going to look like. Comparison of major's to non-majors would be of great interest.

Recommendations

Ideas for instructors of non-biology majors' courses in higher education teaching engaging courses that improve student perception of relevance of biology to everyday life follow in this section. Recommendations for future research on characteristics of successful non-major biology instruction are included.

Recommendations for Practice

Participant comments in the focus group discussions contributed greatly to the study and the recommendations for practice. The results of the Student Experience Survey and student input from the focus groups inter-digitated to create the following list of recommendations:

1. Lecture should be combined with other various forms of instruction to include but not be limited to active learning teaching strategies, inquiry-based learning, with lab and lecture coordinated to reinforce one another, problem-based learning with practical application, and the use of analogies to provide students with connections to pre-existing

experiences and cognitive constructs. Instructor training may be required to correctly implement use of case studies.

2. The content of the entire course should center on the application of each topic in the areas of the human body, the environment and DNA. Providing students with opportunities to see how cell-to-cell communication occurs in their own body for its proper function, how DNA not only determines their genes and proteins which are expressed in their anatomical features and physiological functions, but how DNA determines all of the biodiversity exhibited in nature is practical application of the content. Focusing on how patterns of inheritance determines not only students' own unique body form and function, but an understanding of patterns of inheritance can help students plan for their journey into fertility and reproduction and know what to expect in their own offspring. These topics were identified in the focus group discussions as being more relevant than other topics. Understanding how each is integral to life and survival in the world will give students connections to the content of the course, satisfying their curiosity and providing relevance of the content to everyday life.

3. Instruction should take place in a room conducive to interaction between student and instructor, with comfortable temperature, adequate lighting, and visibility of areas where the instructor is displaying information. While room selection is often out of the control of the instructor, taking an active role in the selection of the instructional environment should be a priority prior to the start of instruction each semester. Searching for alternate instructional environments on campus may need to take priority over convenience of the location of the lectures. Planning for the remodeling of existing

facilities as well as participating in plans for new construction should incorporate the components of the learning environment that have shown to improve student involvement and increase student engagement in the non-major biology courses.

4. Ultimately, using the methods of instruction identified in the focus group discussions, recruiting instructors who are interested in teaching the *students* biology, not *biology to the students*, changing the content of instruction to incorporate or tie the three topics into the core curriculum and utilizing classrooms that foster active learning.

In analyzing the data of this study, it is prudent to suggest training for instructors in pedagogy as is key to reaching the interest level of the non-major, so that connections can be established upon which the non-major can continue to make life-long informed, choices about maintaining the body, bringing children into the world and caring for them, and caring for the environment. It is recommended that instructors incorporate other methods of instruction, in conjunction with lecture, giving students the opportunity to become involved in the instruction process. Inquiry-based learning could be incorporated into homework, where students make discoveries outside of class. An example is to find an analogy outside of class to something covered in the lecture.

At bare minimum, instructors can incorporate every day practical examples or use analogies to help lecture become less boring. Involving student feedback, known as active learning teaching strategies (Freeman, 2007) increases measurable learning in biology major's courses, which tend to be smaller in size, though Freeman reports success in large lecture halls. Instructors are encouraged to incorporate active learning teaching strategies to promote student participation in the course, as Knight and Wood

(2005) propose that even a partial shift toward interactive collaborative strategies can foster significant gains in student learning. Training instructors in new methods of instruction and providing a mentor until they are comfortable would be ideal. Building a general biology course using relevant topics (cases studies) to students is pivotal to student engagement. It is recommended that content be examined for relevance to everyday life, specifically the human body, the environment, and DNA, before incorporating it into a general biology course.

Finally the learning environment affects student engagement. Utilizing classrooms where student can form groups easily and interact with one another and the instructor during the lecture is recommended. Vygotsky's (1978) social constructivism supports this finding in the study. In addition, adequate room temperature, visibility of the board that the instructor is writing on, and proper sound equipment, are necessary for students to become engaged in the course, according to the focus group discussions. Likewise, personality types and instructional abilities of the instructor also play a significant role in student engagement in general biology. These findings are unique to this study and emerged as themes during the focus group discussion.

Recommendations for Future Research

Because the NSES goal is scientific literacy for every individual, to prepare individuals in making decisions life-long decisions that affect the world, there is sufficient motivation for future research in the area of improving student learning in general biology. Recommendation for future studies would include collecting data on student ACT or comparable college entrance exam scores to identify students' aptitudes for the course. Repeating the study using the topics identified by the participants, as well as using alternate methods of instruction is another suggestion based on the list generated collectively by the focus groups. Future studies should include altering the learning environment to provide students with a learning environment conducive to engagement, as well as provide training for instructors in the use of the alternate methods of instruction mentioned in the study.

The Student Experience Survey should be administered after each topic is covered in the course, not waiting until the end of the study allowing too much time to lapse for the students to remember what teaching methods were used. Subsequent Perception of Relevance Surveys could be administered at the end of the semester as well as six months later to assess long term retention of perception of relevance. Another logical change to this study would be to use each of the suggestions from the focus groups about methods of instruction, instructional settings, and even hand selecting instructors that fit the role of the engaging instructor that is interested in the students' lives to test the validity of the recommendations given for conducting an engaging general biology course.

Based on gender differences in the numbers of individuals pursuing STEM, it would be beneficial in future studies to collect data by gender on experiences that students have had in previous biology courses that have affected their interest in the sciences. Collecting data, by gender, not only in the areas defined by this study, but probing deeper into the experiences students had in their K-12 education that have had an influence on their interest in biology would provide some insight into the causation for changing interest levels in both genders prior to entry into higher education. Future

Perception of Relevance Surveys and Student Experience Surveys should be specifically coded for individuals with the use of a PIN so that data can be collected on each student. In addition, future research using focus groups (gender exclusive groups), could be designed to identify if there are differences in what males perceive as relevant and what females perceive as relevant. Likewise, it is recommended that the questions written in the perception of relevance survey be written specifically to determine male and female interests. Additional studies fostered by the results of this study should include, but are not limited to exploring a threshold of motivation by gender, additional questions about perception of relevance and gender, as well as choice of college major and its effect on motivation as well as perception of relevance.

In another related extension of this study, in light of the fact that the number of individuals entering STEM fields is declining and that many biology majors change their major by the end of their four year academic plan (Sorenson, 2000), future research using the findings of this study in biology majors' courses is recommended. Use of the study recommendations starting at the beginning of the biology major four year program, would merit some thought and extended study would add to the current body of knowledge on retention in biology programs. Freeman's (2007) study indicates active learning teaching strategies were instrumental in retention of biology majors. It is reasonable to expect additional success with the recommendations proposed by this study.

Implications

The significance of the study is the identification of what is and what is not working in the general biology classroom for non-biology majors in higher education where increasing perception of relevance is the instructional goal. The goal of this study and the use of its findings were to develop ways to increase students' perception of relevance. It is the instructional means of choice in biology courses for Hohman, Adams, Taggart, Heinrichs, and Hickman (2006), Osborne (2003), and the principal researcher for helping students make connections between science content and their personal lives. Educating citizens to make life-long knowledgeable decisions about their health, life, and the environment is the ultimate goal of the NSES. Participants in the focus groups helped identify topics that most individuals immediately see application of consequences if action is not taken. By selecting topics relating to the human body, the environment, and DNA, the three main topics that students found interesting as well as relevant to their everyday life, instructors are equipped with ways in which to help students connect biology content to everyday life. Instructional methods that promote active engagement, making the lab part of the course significant in the presentation of content, and selecting classrooms that are conducive to interaction with the professor and other students, that also have proper lighting and ventilation, reaching that goal is possible in higher education non-biology major courses. Non-major biology courses have the potential to stimulate interest in biology by equipping non-majors with the skills to troubleshoot situations that arise in everyday life that require knowledge of biological concepts and employ the use of skills learned in the redesigned course where students practice using knowledge and decision making skills to solve real life dilemmas. Herried (2008) states that, “As a professor, your greatest impact is on the non-biology majors (p.439)”.

By stimulating interest, general biology courses have the potential of increasing numbers of students going *into* STEM fields. According to Knight and Wood (2005), with just a little effort utilizing active engagement methods of instruction, students show improvement in measureable outcomes. Further implications of this study reach into the realm of the biology *major*. Implementing the recommendations of this study, that is, focus the course on topics relating to the human body, DNA and the environment, recruit instructors with high energy personal and instructional skills, utilize active engagement during instruction, provide interactive laboratory opportunities, and utilize classrooms that foster student engagement in the biology majors’ courses has the potential of increasing the retention rate of biology majors that have begun their four year academic plan, much like Freeman’s (2007) positive retention results using only one of the recommendations posed by the participants in the focus group discussions. With the drafting and passing of the NSES (1996), science education has changed from content to conceptual knowledge, with students needing to be able to apply science to everyday life rather than to recite simple facts (Knight & Wood, 2005), higher education is the natural extension of the science literacy program that exists in the K-12 education and the opportunity to make all citizens scientifically literate in the end.

REFERENCES

Adamuti-Trache, M., & Andres, L. (2008, October). Embarking on and persisting in scientific fields of study: Cultural capital, gender, and curriculum along the science pipeline. *International Journal of Science Education, 30*(12), 1557-1584.

Allen, D., & Tanner, K. (2005). Infusing active learning into the large-enrollment biology class: Seven strategies, from simple to complex. *Cell Biology Education*, 4, 262-268.

American Association for the Advancement of Science. (1989). *Science for all Americans: Project 2061*. Washington , DC: AAAS

American Association for the Advancement of Science. (2001). *Atlas of Science Literacy: Project 2061*. Washington, DC: AAAS & National Science Teachers Association.

American Association for the Advancement of Science. (1996). *Benchmarks for science literacy*. New York: Oxford Press.

Arons, A. B. (1997). *Teaching introductory physics.* New York: Wiley.

Astin, A. (1985). *Achieving educational excellence*. San Francisco: Jossey-Bass.

Bain, K. (2004). *What the best college teachers do.* Cambridge, MA: Harvard University Press.

Bandura, A. (1977). *Social learning theory*. New York: General Learning Press.

Barab, S. A., & Duffy, T. M. (2000). From practice fields to communities to practice. D. H. Jonassen, S. W. Land (Eds.), *Theoretical Foundations of Learning Environments* (pp. 25-55). Mahwah, NJ: Erlbaum.

Bartling, J. D. (2009) Faculty and administrator perceptions of teaching, the scholarship of teaching and learning, and culture at a teaching university. (Doctoral dissertation). Retrieved from ProQuest. UMI 3344920.

Becker, L., & Schneider, K. (2004, August/September). *Motivating students: Eight simple rules for teachers*. The Teacher Professor , 1-2.

Beeth, M. E., Adadan, E., Firat, G., & Kutay, H. (2003). *The changing face of biology 101 with regards to the nation's science standards*. Paper presented at the meeting of the Association for the Education of Teachers of Science, St. Louis, MO.

Beichner, R. J., & Saul, J. M. (2003). Introduction to the SCALE-UP (Student-Centered Activities for Large Enrollment Undergraduate Programs) Project. Proceedings of the International School of Physics "Enrico Fermi," Varenna, Italy. Http://www.ncsu.edu/per/scaleup.html (accessed 8 June 2010).

Berg, B. L. (1998). *Qualitative research methods for the social sciences* (3rd ed.). Boston, MA: Allyn & Bacon.

Berry, J. (2000).Can you teach biology through storytelling? Yes, says UB prof. *Journal of the American Dental Association*, 131(4), 439.

Blickenstaff, J. C. (2005, October). Women and science careers: Leaky pipeline or gender filter?. *Gender and Education, 17*(4), 369-386.

Bloom, B. (Ed.). (1956). *Taxonomy of educational objectives: The classification of educational goals: Handbook 1: The cognitive domain.* New York: David McKay.

Bouda, D., Cohena, R., & Sampsona, J. (1999). Peer learning and assessment. *Journal of Assessment and Evaluation in Higher Education*, 24(4), 413-426.

Boehrer, J., & Linsky, M. (1990). Teaching with cases: Learning to question. *New Directions for Teaching and Learning*, 42, 41-57.

Brainard, J. (2007). The tough road to better science teaching. *The Chronicle of Higher Education*, 53(48), A16.

Brophy, J. (1985). Interactions of male and female students with male and female teachers. In L. C. Wilkinson & C. B. Marrett (Eds.), *Gender influences in classroom interaction.* New York: Academic Press.

Brommer, C. (2007). Cases, writing, and students becoming teachers; A new way to enhance undergraduate science education. *The FASEB Journal*, 21(5).

Bureau of Labor Statistics, U.S. Department of Labor, *Career Guide to Industries, 2010-11 Edition*, Healthcare. (August 09, 2010; www.bls.gov/oco/cg/cgs035.htm).

Bush, G. (2006, December). Learning about learning: From theories to trends. *Teacher Librarian, 34(2),* 14-18. Retrieved from Academic Search Premier database.

Caelli, K., Ray, L., & Mill, J. (2003). 'Clear as mud': Toward greater clarity in generic qualitative research. *International Journal of Qualitative Methods*, 2(2), 1-13.

Carbone, E., & Greenberg, J. (1998). Teaching large classes: Unpacking the problem and responding creatively. In M. Kaplan (Ed.), *To Improve the Academy*, 17, Stillwater, OK: New Forums Press and The Professional and Organizational Development Network in Higher Education.

Carmichael, J. (2009, March/April). Team-based learning enhances performance in introductory biology. *Journal of College Science Teaching*, 38(4), 54-61.

Cavanagh, S. (2007). Science labs: beyond isolationism. *Education Week*, 26(18), 24-26.

Chaplin, S., & Manske, J. (2005, September). A theme based approach to teaching non-majors biology. *Journal of College Science Teaching, 35*(1), 47-51.

Chin, C., & Chia, L. (2006). Problem-based learning: Using ill-structured problems in biology project work. *Science Education*, 90(1), 44-67.

Claxton, G. (1983). School science: Falling on stony ground or chocked by thorns. Unpublished manuscript, Chelsea College, University of London.

Cleaves, A. (2005). The formation of science choices in secondary school. *International Journal of Science Education, 27*(4), 471-486.

Cliff, W. H., & Nesbitt, L. M. (2005). An open or shut case? *Journal of College Science Teaching*, 34(4), 14-17.

Coker, J. (2009). Reinventing life: Introductory biology for a rapidly evolving world. *American Biology Teacher*, 71(5), 281-284.

Conley, D. (2007). The challenge of college readiness. *Educational Leadership*, 64(7), 7-7.

Cook, T. D., & Reichardt, C. S. (Eds.). (1979). *Qualitative and quantitative methods in evaluation research.* Beverly Hills, CA: Sage.

Creswell, J. W. (2003*). Research design: Qualitative, quantitative, and mixed methods approaches* (2nd ed.). Thousand Oaks, CA: Sage.

Creswell, J. (2005). *Educational research: Planning, conducting and evaluating quantitative and qualitative research*. Upper Saddle River, NJ: Pearson Merrill Prentice Hall.

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among the five traditions* (2nd ed.). Thousand Oaks: Sage.

Crosby, G. A. (1996). Implications of the national science education standards for higher education. *Journal of Chemical Education*, 73(9), A200-A201.

Crossgrove, K., & Curran, K. (2008). Using clickers in nonmajors- and majors-level biology courses: Student opinion, learning, and long-term retention of course material. *CBE-Life Sciences Education*, 7, 146-154.

Crouch, C., & Mazur, E. (2001). Peer instruction: Ten years of experience and results. *American Journal of Physics*, 69(9), 970-977.

Demir, A., Schmidt, F., & Abell, S. K. (2010, May/April). Science from the pond up: Using measurements to introduce inquiry. *Journal of College Science Teaching*, 39(4), 23-27.

Dimaculangan, D. D., Mitchell, P. L., Rogers, W., Schmidt, J. M., Chism, J. L., & Johnston, J. W. (2000). A multidimentional approach to teaching biology. *Journal of College Science Teaching*, 29(5), 330-336.

Driscoll, M. P. (1994). *Psychology of learning for instruction*. Boston: Allyn and Bacon.

Driver, R. & Oldham, V. (1986). A constructivist approach to curriculum development in science. *Studies in Science Education, 13,* 105-22.

Druger, M. (1999). National standards for introductory college sciences courses: Can and should we have them? *Journal of Science Teaching*, 29(3), 154-155,209.

Feagin, J., Orum, A., & Sjoberg, G. (1991). *A case for case study*. Chapel Hill, NC: University of North Carolina Press.

Felder, R. M. (2000). The alumni speak. *Chemical Engineering Education*, 34, 238-239.

Felder, R., & Brent, R. (2006). How to teach almost anybody almost anything. *Chemical Engineering Education , 40* (3), 173-174.

Firooznia, F. (2006). Giant ants and walking plants. *Journal of College Science Teaching*, 35(5), 26-31.

Fitzpatrick, J. L., Sanders, J. R., & Warthen, B. R. (2004). *Program evaluation: Alternative approaches and practical guidelines.* Boston: Pearson.

Fox, M. (1998). Improving undergraduate science education - National initiatives, local implications. *Journal of Science Teaching*, 29(3), 373-375.

Francom, G., Bybee, D., Wolfersberger, M., & Merrill, M. D. (2009, May/June). Biology 100: A task-centered, peer-interactive redesign. *TechTrends*, 53(3), 35-42.

Freeman, S. (2007, September 29). Active learning workshop: Active learning basics. Lecture presented at University of Chicago, Chicago, Illinois.

Freeman, S. (2008, September 27). Active learning workshop: Making the transition. Lecture conducted at University of Wisconsin, Madison, Wisconsin.

Freeman, S., O'Connor, E., Parks, J. W., Cunningham, M. Hurley, D., Haak, D., Dirks, C., & Wenderoth, M. P. (2007). Prescribed active learning increases performance in introductory biology. *CBE Life Sciences Education* , 6 (2), 132-139.

French, D., Cheesman, I., Swails, N., Thomas, J., & Cheesman, K. (2007). Is there any common curriculum for undergraduate biology majors in the 21st century*?* *Bioscience*, 57(6), 516-522.

Fuselier, L., & Jackson, J. K. (2010). Perceptions of collaboration, equity, and values in science among female and male college students. *Journal of Baltic Science Education, 9*(2), 109-118. Retrieved from Academic Search Premier database.

Gallucci, K. (2006, October). Learning concepts with cases*.* *Journal of College Science Teaching*, 36(2), 16-20.

Gedrovics, J., Wareborn, I., & Jeronen, E. (2006). Science subjects choice as a criterion of students' attitudes to science. *Journal of Baltic Science Education*, 1(9), 38-49.

George, D. & Mallery, P. (2007). *SPSS for windows step by step: a simple guide and reference* 14.0 update. Boston: Pearson.

Gilligan, C. (1982). *In a Different Voice*. Cambridge, MA: Harvard University Press.

Gregory, R. (2011) *Psychological testing: History, principles, and applications*. (6^{th} ed). Boston, MA: Allyn & Bacon.

Hake, R. (1998, January). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics*, 66(1), 64-74.

Haller, C., Gallagher, V., Weldon, T., & Felder, R. (2000). Dynamics of peer education in cooperative learning workgroups. *Journal of Engineering Education*. 89 (3), 285-293.

Hammond, W. F. (1997). Educating for action. *Green Teacher*, 50, 6-14.

Hanna, D. E. (2003). Building a leadership vision: eleven strategic challenges for higher education. *Educause Review, 38(4),* 25-34.

Herreid, C. F. (1999, February). The bee and the groundhog. *Journal of College Science Teaching, 28(4),*226-228.

Herreid, C. F. (2005). Mother always liked you best: Examining the hypothesis of parental favoritism. *Journal of College Science Teaching, 35*(2), 10-14.

Herreid, C. F. (2008). "Clicker" cases: Introducing case study teaching into large classrooms. *Journal of College Science Teaching*, 63(2), 43-47.

Hewlett, J. A. (2004). In search of synergy. *Journal of College Science Teaching*, 33(4), 28-31.

Hobson, A. (2000/2001). Teaching relevant science for science literacy. *Journal of College Science Teaching, 30,* 238-243.

Hohman, J., Adams, P., Taggart, G., Heinrichs, J., & Hickman, K. (2006). A "Nature of Science" discussion: Connecting Mathematics and Science. *Journal of College Science Teaching*, *36*(1), 18-21.

Johnson, D., Johnson, R., & Smith, K. (1991). *Active learning: Cooperation in the classroom.* Edina, MN: Interaction.

Johnson, D. W., Johnson, R. T., & Smith, K. A. (1998). *Active learning: Cooperation in the college classroom* (2nd ed). Edina, MN: Interaction.

Jonassen, D. H., & Land, S. M. (Eds.). (2000). *Theoretical foundations of learning environments*. Mahwah, New Jersey: Erlbaum.

Jones, G., & Wheatley, J. (1990). Gender differences in teacher-student interactions in science classrooms. *Journal of Research in Science Teaching*, 27(9), 861-874.

Kahle, J. B. (1990). Real students take chemistry and physics: Gender issues. In K. Tobin, J. B. Kahle, & B. J. Fraser (Eds.), Windows into science classrooms: Problems associated with higher-level cognitive learning(pp. 92-134). New York: Falmer.

Kahle, J., & Meece, J. (2004). Research on gender issues in the classroom. In D. L. Gabel (Ed.), *Handbook of research on science teaching and learning: A project of the National Science Teachers Association* (pp. 542-557). New York: Macmillan.

Keller, J., & Suzuki, K. (1988). Use of the ARCS motivation model in courseware design. In *Instructional design for microcomputer courseware*, 401-434. Hillsdale, NJ: Lawrence Erlbaum Associates.

Kidman, G. (2008). Asking students: What key ideas would make classroom biology interesting? *Teaching Science - the Journal of the Australian Science Teachers Association,* 54(2), 34-38.

Kieser, J., Herbison, P., & Harland, T. (2005, November). The influence of context on students' approaches to learning: A case study. *European Journal of Dental Education: Office Journal of the Association for Dental Education in Europe*, 9(4), 150-156.

Knight, J., & Wood, W. (2005). Teaching more by lecturing less. *Cell Biology Education*, 4, 298-310.

Krueger, R., & Casey, M. (2009). *Focus groups: A practical guide for applied research*. Thousand Oaks, CA: Sage.

Lederman, N., Hall, J., Nyberg, L., & Ritz, W. (1998). An NSTA position statement: The National Science Education Standards: A vision for the improvement of science teaching and learning. *Journal of College Science Teaching*, 28(1), 13-15.

Leedy, P., & Ormrod, J. (2005), *Practical research: Planning and design* (8^{th} ed.) Upper Saddle River, NJ: Pearson.

Litchfield, B., Mata, J., & Gray, L. (2007, Novermber/December). Engaging general biology students. *Journal of College Science Teaching*, 37(2), 34-39.

Liu, C. & Matthews, R. (2005). Vygotsky's philosophy: Constructivism and its criticisms examined. *International Education Journal, 6(3),* 386-399.

Lord, T. (1998, October). Cooperative learning that really works in biology teaching: Using constructivist-based activities to challenge student teams. *The American Biology Teacher*, 60(8), 580-588.

Lord, T., & Baviska, S. (2007, March/April). Moving students from information recitation to information understanding. *Journal of College Science Teaching*, 36(5), 40-44.

Marcus, B. (1993). Community colleges and non-majors biology courses. *BioScience, 43*(9), 632-637.

Marx, G. (2006). *Future-focused leadership: Preparing schools, students, and communities for tomorrow's realities*. Alexandria, VA: ASCD.

McKeachie, W. J. (2002). *Teaching tips: Strategies, research, and theory for college and university teachers* (11th ed.). Boston: Houghton Mifflin.

McClanahan, E., & McClanahan, L. (2002). Active learning in a non-majors biology class lessons learned. *College Teaching*, 50(3), 92-96.

Morgan, D. (1997). *Focus groups as qualitative research 2nd ed.: Qualitative research method series 16*. Thousand Oaks, CA: Sage.

The National Academies. (2010). *Conceptual Framework for New Science Education Standards.* Retrieved from http://www7.nationalacademies.org/bose/Standards_Framework_Homepage.html.

National Research Council. (1996). *National Science Education Standards.* Washington, DC: National Academy Press.

National Research Council, Committee on Undergraduate Science Education. (1997). *Science teaching reconsidered: A handbook.* Washington, DC: National Academies Press.

National Science Foundation. (1989). Report of the biology workshop. In *Report on the national science foundation disciplinary workshops on undergraduate education,* 13-18.

National Science Foundation (NSF). (1990). *Women and minorities in science and engineering*(NSF 90-301). Washington, DC: Author.

Newman, I., & Benz, C. R. (1998). *Qualitative-quantitative research methodology: Exploring the interactive continuum.* Carbondale: Southern Illinois University Press.

Oliver, R. (2007). Exploring an inquiry-based learning approach with first-year students in a large undergraduate class. *Innovations in Education and Teaching International*, 44(1), 3-15.

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education, 25(9),* 1049-1079.

Osborne, J., Driver, R., & Simon, S. (1996). Primary science: Past and future directions. *Studies in Science Education*, 27, 99-147.

Osborne, J., Driver, R., & Simon, S. (1998). Attitudes toward science: Issues and concerns. *School Science Review*, 79 (288), 27-33.

Ormrod, J. E. (2004). *Human learning*. Upper Saddle River, New Jersey: Pearson Prentice Hall.

Palmer, D. (2005). A motivational view of constructivist-informed teaching. *International Journal of Science Teaching*, 27(15), 1853-1881.

Percy, W. H., & Kostere, K. (2008, July). *Qualitative research approaches in psychology*. Unpublished manuscript, Department of Psychology, University of Capella, Minneapolis, MN. Available from www.capella.edu

Random House College Dictionary. (1973). New York: Rand McNally.

Rosser, S. V. (2004). *The science glass ceiling: Academic women scientists and the struggle to succeed.* Oxford, UK: Taylor & Francis.

Salish Research Consortium. (1997). *Secondary Science and Mathematics Teacher Preparation Programs: Influences on New Teachers and Their Students: Final Report of the Salish I Research Project (SALISH I).* Iowa City: University of Iowa, Science Education Center.

Salish II Research Project. (1998, July). Translating and using research for improving teacher education in science and mathematics: The final report from the OERI-funded Chautauqua ISTEP research project.

Sandell, O. (2007). Learning as acquisition or learning as participation? *Thinking Classroom*, 8(1), 19-26.

Scherer, M. (2007). Are they ready? *Educational Leadership*, 64(7), 7.

Scholes, M. (2002). Games worth playing: Effective science teaching through active learning. *South African Journal of Science*, 98(9-10): 497-499.

Schwebach, J. R. (2001). Implementing national science educational standards - a scientist's responsibility, too. *Einstein Quarterly Journal of Biology and Medicine*, 18(2), 84-85.

Seymour, E., & Hewitt, N. (1997). *Talking about leaving: Why undergraduates leave the sciences*. Boulder, Colorado: Westview Press.

Siebert, E. D., & McIntosh, W. J. (Eds). (2001). *College pathways to the science standards.* Arlington, Virginia: National Science Teachers Association.

Sjoberg, S. (2001). *Science and technology in education - current challenges and possible solutions.* Invited contribution to Meeting of European Ministers of Education and Research, Uppsala 1-3 March 2001. Retrieved from http://scholar.google.com.

Sjoberg, S., & Schreiner, C. (2005). Young people and science: Attitudes, values, and priorities: Evidence from the ROSE project. Keynote presentation at the European Union Science and Society Forum, Brussels, March 2005. Accessed 9 February 2010. http://www.ils.uio.no/english/rose/network/countries/norway/eng/nor-sjoberg-eu2005.pdf.

Slavin, R. (1995). Cooperative learning: Theory, research and practice. (2nd ed.). Needham Heights, MA.

Smith, K. A., Sheppard, S. D., Johnson, D. W., & Johnson, R. T. (2005). Pedagogies of engagement: Classroom-based practices. *Journal of Engineering Education*, January *2005*,1-16.

Smith, R., & Murphy, S. (1998). Using case studies to increase learning and interest in biology. *American Biology Teacher*, 60(4), 265-68.

Sokolove, P. G. (1998, January). The challenge of teaching biology 100: Can I really promote active learning in a large lecture?. In M. Gardner (Ed.), *Journeys of Transformation: A Statewide Effort by Mathematics and Science Professors To Improve Student Understanding. Case Reports from Participants in the Maryland Collaborative for Teacher Preparation* (pp. 121-128). Towson, MD: Maryland

Sorensen, K. H. (2000). Factors influencing retention in introductory biology curriculum. Paper presented at the Annual Meeting of the National Association for Research in Science Teaching, Boston, MA.

Stewart, D., Shamdasani, P., & Rook, D. (2007). *Applied social research methods series: Volume 20*. Thousand Oaks, CA: Sage

Sungur, S., Tekkaya, C., & Geban, O. (2006). Improving achievement through problem-based learning. *Journal of Biological Education*, 40(4), 155-160.

Taba, H. (1962). *Curriculum development: Theory and practice*. New York: Harcourt, Brace, & World.

Tellis, W. (1997, July). *Introduction to case study* [68 paragraph]. The Qualitative Report [On-line serial], 3(2). Available: http://www.nova.edu/sss/QR/QR3-2/tellis1.html

Tessier, J. (2007, January/February). Small-group peer teaching in an introductory biology classroom. *Journal of College Science Teaching*, 36(4), 64-69.

Tinto, V. (1987). *Rethinking the Causes and Cures for Student Attrition*. Chicago: University of Chicago Press.

Tolman, E. C. (1948). Cognitive maps in rats and men. *The Psychological Review*, 55(4), 189-208.

Travis, H. & Lord, T. (2004). Traditional and constructivist teaching techniques. *Journal of College Science Teaching*, 34(3), 12-18.

Udovic, D., Morris, D., Dickman, A., Postlethwait, J., & Wetherwax, P. (2002). Workshop biology: Demonstrating the effectiveness of Active Learning in an introductory biology course. *BioScience*, 52(3), 272-281.

U. S. Census Bureau. (2008). Statistical Abstract of the United States: 2008 Table 598. Employed Civilians by Occupation, Sex, Race, and Hispanic Origin. Retrieved August 9, 2010, from www.census.gov/prod/2007pubs/08abstract/labor.pdf.

Varma-Nelson, P. (2006). Peer-led team learning. *Metropolitan Universities*, 17(4), 19-29.

Vasquez, J. (1996). Invited paper. *The Science Teacher*, 63(6), 8.

Von Glasersfeld, E. (1987). Learning as a constructive activity. In C. Janvier (ed.), *Problems of representation in the teaching and learning of mathematics* (pp.3-17). Hillsdale, NJ: Erlbaum.

Vygotsky, L.S. (1978). *Mind in Society: The development of higher psychological processes.* Cambridge, MA: Harvard University Press.

Wallace, C. S., Tsoi, M. Y., Calkin, J., & Darley, M. (2003). Learning from inquiry-based laboratories in nonmajor biology: An interpretive study of the relationships among inquiry experience, epistemologies, and conceptual growth. *Journal of Research in Science Teaching*, 40(10), 986-1024.

Waterman, M. A. (1998). Investigative case study approach for biology learning. Bioscene: *Journal of College Biology Teaching*, 24(1), 3-10.

Weisgram, E. S., & Bigler, R. S. (2007). Effects of learning about gender discrimination on adolescent girls' attitudes toward and interest in science. *Psychology of Women Quarterly, 31,* 262-269.

Wertsch, J. V. (1988). *Vygotsky and the social formation of mind.* Cambridge, MA: Harvard University Press.

Wink, J. P., & Putney, L. (2002). *A Vision of Vygotsky.* Boston: Allyn and Bacon.

Wood, B. S. (2009). *Lecture-free teaching: a learning partnership between science educators and their students. National Science Teachers Association.*

Woolnough, B. E. (1994). *Effective Science Teaching*. Philadelphia: Open University Press.

Yager, R., Kaya, O., & Dogan, A. (2007). College science teaching changing to mirror real science in turkish higher education. *Journal of College Science Teaching*, 36(7), 50-54.

Yankelovish, D. (2005). Ferment and change: Higher education in 2015. *Chronicle of Higher Educatio*n, 52(14), B6-B9.

Yin, R. (1994). *Case study research: Design and methods* (2nd. ed.). Beverly Hills, CA: Sage.

Yoshikawa, H., Weisner, T., Kalil, A., & Way, N. (2008, March 1). Mixing qualitative and quantitative research in developmental science: Uses and methodological choices. *Developmental Psychology*, 44(2), 344.

Zonabend, F. (1992, Spring). The monograph in European ethnology. *Current Sociology*, 40(1), 49-60.

APPENDIX A. SURVEY OF PERCEPTION OF RELEVANCE

1. What is your gender?
   A = male
   B = female

2. How would you rate your overall level of interest in biology?
   A = extremely high
   B = high
   C = moderate
   D = little
   E = not at all

For each statement, fill in the circle that best describes your feelings about each topic.
A = almost always
B = often
C = sometimes
D = seldom
E = almost never

Cell-to-cell Communication

3. I am interested in learning about the cell-to-cell communication.

4. I learn about the cell-to-cell communication outside of school.

5. New learning starts with problems about the cell-to-cell communication outside of school.

6. I learn how the cell-to-cell communication can be a part of my out-of- school life.

7. I get a better understanding of the cell-to-cell communication outside of school.

8. I learn interesting things about the cell-to-cell communication outside of school.

9. What I learn about the cell-to-cell communication has nothing to do with my out-of- school life.

10. What I learn about the cell-to-cell communication has nothing to do with the world outside of school.

Genes and Proteins

11. I am interested in learning about genes and proteins.
12. I learn about genes and proteins outside of school.
13. New learning starts with problems about genes and proteins outside of school.
14. I learn how genes and proteins can be a part of my out-of- school life.
15. I get a better understanding of genes and proteins outside of school.
16. I learn interesting things about genes and proteins outside of school.
17. What I learn about genes and proteins has nothing to do with my out-of- school life.
18. What I learn about genes and proteins has nothing to do with the world outside of school.

Patterns of Inheritance

19. I am interested in learning about patterns of inheritance.
20. I learn about patterns of inheritance outside of school.
21. New learning starts with problems about patterns of inheritance outside of school.
22. I learn how patterns of inheritance can be a part of my out-of- school life.
23. I get a better understanding of patterns of inheritance outside of school.
24. I learn interesting things about patterns of inheritance outside of school.
25. What I learn about patterns of inheritance has nothing to do with my out-of-school life.
26. What I learn about patterns of inheritance has nothing to do with the world outside of school.

APPENDIX B. SURVEY OF STUDENT EXPERIENCES WITH METHODS OF INSTRUCTION

For each question use the following answer sheet.
A = yes
B = no

While attending the lectures and labs over the past 5 weeks, have you observed any of the following methods of instruction?

1. Professor speaking to the class providing the content of the course.
2. Group work where you were held accountable for specific part of the project, where the whole team suffered if you did not complete your part?
3. Group work where you had your own component, but were held accountable for mastery of each of the other participants' information?
4. Group work with face to face interaction where team mates provide feedback as well as encouragement?
5. Group work where collaborative skills were exercised like trust-building, leadership, communication, conflict resolution and decision making?
6. Group work where goals were set and progress was assessed identifying changes to be made to improve the project outcomes?
7. Questions posed with answers given by an immediate response system like clickers or colored notecards that can be held up to register your answer?
8. Questions posed with a minute given to work with another student to figure out the answer before responding to the instructor?
9. Opportunity to write the muddiest point of the topic and turn in to the instructor?
10. Opportunity to write exam questions?
11. Writing for one minute on your understanding of a topic?

12. Discussion of exam questions from previous quarters?
13. Using a story about individuals or a group in which you assumed the identity of one of the members in the story in an effort to solve the dilemma?
14. Using a story with questions given to you about the nature of the situation?
15. Using a story to investigate the facts and decisions to be made about the story?
16. Labs where you explored the reason and results of science phenomenon?
17. Labs where you formulated hypothesis, designed experiments, analyzed data from your findings, and gave report of your findings?

18. Do you have any comments that you would like to add to any of the questions?
19. Please write the number of the question, followed by the comment.

APPENDIX C. STUDENT FOCUS GROUP DISCUSSION QUESTIONS

1. What is your name, major, and academic year you are in?
2. How relevant do you think biology is to everyday life?
3. What biology topics, if any, do you think are more relevant than others?
4. How important do you think the way a teacher presents his information is?
5. What ways do you see as important when it comes to how an instructor communicates and presents his information in class?
6. Do you have any prior experiences with teaching styles that help you connect with the information of a class?
7. In General Biology, is there anything that the professor did in class to make the information seem more pertinent to everyday life?
8. What stands out in your memory about the importance of …cell-to-cell communication? …Genes and proteins? …patterns of inheritance?
9. What, if anything, did the instructor do that helped you connect cell-to-cell communication, genes and proteins, and patterns of inheritance to everyday life experiences or those to come?
10. What would you like to see instructionally in the general biology class to make that happen?
11. Can you add anything to the discussion that was not covered?

APPENDIX D. EXPERT PANEL FOR FOCUS GROUP DISCUSSIONS, MODIFICATIONS OF PERCEPTION OF RELEVANCE SURVEY QUESTIONS, AND STUDENT EXPERIENCE DURING INSTRUCTION SURVEY

Expert 1, PhD, MS, MBA, LD, RD

Expert 1 is a recent graduate of Capella University, Minneapolis, Minnesota. School of Education. Specialization; Ph.D. in Professional Studies; September 2010.
Dissertation topic: University Faculty Members' Perception of Group Work: How Knowledge and Experience Guide Practice. She received her Masters of Science in Clinical Dietetics; June 2005 Rosalind Franklin University of Medicine and Science, Chicago, Illinois. She received her Masters of Business Administration from Olivet Nazarene University, Bourbonnais, Illinois. ; May 1995.
Eastern Illinois University, Charleston, Illinois; Bachelor of Science in Home Economics Education; minor: Psychology. Her research experience has been at the doctorate level as a part of the requirements for her PhD.

Expert 2, PhD

Expert 2 teaches in the Physical Sciences Department. He teaches the General Physical Science course, and a number of upper-division Geology courses. He has served on a number of committees including Professional Development and General Education Committees. He is a member of the Education Subcommittee for the state Geographical Information Systems Association and a member of the National Science Teachers Association. He also has extensive industry experience including 10 years in oil & gas production, and nine years in environmental restoration. He is active in consulting on environmental problems for the government.

Expert 3, MA Ed

Expert 3has taught in the Geology Department at Olivet Nazarene University since 2005. She teaches the Secondary and Middle School Science Teaching Methods course, and supervises teacher candidates in field placements and student teaching. She has worked on the NCATE review committee for the School of Education and serves as a member of the Bias Review Committee for the Illinois Certification Testing System and Illinois State Board of Education. She has co-authored papers presented at the Geological Society of America (GSA) annual conferences. She is a member of the National Science Teachers Association and is the faculty advisor for the Olivet Nazarene University student chapter of NSTA.

Expert 4, Ph.D.

Expert 4is a 2009 graduate of Capella University, School of Education with a PhD in Professional Studies. The dissertation topic was in Nursing Education on the Clinical Self-efficacy and Learner Satisfaction of Nursing Students. She received her Master of Science in Nursing; May 1978 Texas Woman's University, and her Bachelor of Science in Nursing: May 1974, University of Texas. Her research experience has been at the masters and doctorate level.

APPENDIX E. CODING FOR STUDENT SURVEY OF OBSERVED BEHAVIORS FOR IDENTIFICATION OF METHODS OF INSTRUCTION

Lecturing

1. Professor speaking to the class providing the content of the course.

Cooperative learning

2. Group work where you were held accountable for specific part of the project, where the whole team suffered if you did not complete your part?
3. Group work where you had your own component, but were held accountable for mastery of each of the other participant's information?
4. Group work with face to face interaction where team mates provide feedback as well as encouragement?
5. Group work where collaborative skills were exercised like trust-building, leadership, communication, conflict resolution and decision making?
6. Group work where goals were set and progress was assessed identifying changes to be made to improve the project outcomes?

Active Learning Teaching Strategies

7. Questions posed with answers given by an immediate response system like clickers or colored notecards that can be held up to register your answer?
8. Questions posed with a minute given to work with another student to figure out the answer before responding to the instructor?
9. Opportunity to write the muddiest point of the topic and turn in to the instructor?
10. Opportunity to write exam questions?
11. Writing for one minute on your understanding of a topic?
12. Discussion of exam questions from previous quarters?

Problem-based Learning

13. Using a story about individuals or a group in which you assumed the identity of one of the members in the story in an effort to solve the dilemma?
14. Using a story with questions given to you about the nature of the situation?
15. Using a story to investigate the facts and decisions to be made about the story?

Inquiry-based Learning

16. Labs where you explored the reason and results of science phenomenon?
17. Labs where you formulated hypothesis, designed experiments, analyzed data from your findings, and gave report of your findings?

APPENDIX F. CODE FOR PERCEPTION OF RELEVANCE SURVEY

Question 3 through 8, responses A-E have values of one through five points, for questions 9 and 10, the values are reversed with A-E having values of five through -8 have positive values. This pattern is repeated for each set of eight questions, reflecting the question set asked in the Perception of Relevance Survey, regarding each of the biology topics in the study.

Questions 3-8, 11-16, and 19-24

A = 1
B = 2
C = 3
D = 4
E = 5

Questions 9-10, 17-18, and 25-26

A = 5
B = 4
C = 3
D = 2
E = 1