2018

An Analysis of the Motivational Type Exhibited by Students after their High School Biology Course fulfilling the Minnesota Science Standards in Biology

Cheryl A. Moertel
Bethel University

An Analysis of the Motivational Type Exhibited by Students after their High School Biology Course fulfilling the Minnesota Science Standards in Biology

by
Cheryl Ann Moertel

A dissertation submitted to the faculty of Bethel University
in partial fulfillment of the requirements for the degree of
Doctor of Educational Leadership

Saint Paul, MN
2018

Approved by:

Advisor: Patricia Paulson

Reader: Michael Lindstrom

Reader: David Pugh

Abstract

Ninth-grade students were given a survey modified from the work of Aydin, Yerdelen, Gurbuzuglo, Yalmanci, and Goksu (2014) following completion of their high school biology course which asked for their level of agreement on 18 statements regarding motivation to learn biology. The results from the state assessment in biology standards competencies were correlated with reported motivation type and level. Students were asked to indicate their course choice, identified culture, gender, and whether they qualified for free or reduced-priced lunch. The results indicated that the course in which the student had been enrolled showed a significant correlation with atrinsic and extrinsic social motivation. The data also showed that young women enrolled in a biomedical science course reported the highest levels of motivation in all areas except atrinsic motivation in which they showed the lowest levels. Black students in all courses reported the highest levels of atrinsic motivation and Hispanic students reported the lowest levels of extrinsic career motivation. State science scores were positively correlated with intrinsic and extrinsic social motivation and were negatively correlated with atrinsic motivation. Students who qualified for free or reduced-price lunch reported equal motivation to other students.

Dedication

This dissertation is dedicated to my late parents, Paul and Mabel Holthaus, and to my husband, David Moertel, the three people in my life who always believed I could successfully do anything I wanted to do. It is also dedicated to my children, Jessica Moertel and Ryan Moertel who helped to build my intrinsic motivation to study learning as I participated in learning with them as they grew up. A very special dedication goes to my first grand-daughter who will be arriving soon. Without her motivating me with the extrinsically social title of "Doctor Grandma", little would have been accomplished. As always, without the unfailing support and faith of my family, I would never have come so far as to write a dissertation for a doctoral degree.

Acknowledgements

A special thank you is due to the biology department at Century High School in Rochester, Minnesota. Without the help, support, and teaching skills of Paul Callahan, Janelle Milliken, and Laura Unterholzner, this study would not have been possible. The ninth-grade students in Rochester have been truly blessed with incredible teachers who care deeply that all students are motivated to perform and learn at their highest potential.

A second thank you goes to the administration at Century High School who supported this project (Christopher Fogarty, Molly Murphy, Mary Schoenbeck, and Kurt Verdoorn) and helped to make data collection possible. Thank you also to district administrators Michael Munoz, superintendent, and Heather Willman, curriculum and instruction, who gave permission and advice in the design and implementation of this study.

The work of Salmaz Aydin and her colleagues is acknowledged and appreciated. Their Academic Motivation Scale for Learning Biology was used with the author's permission in this study (see Appendix A and Appendix D).

Finally, appreciation goes to the Bethel University advisors for this dissertation; Patricia Paulson, Michael Lindstrom, and David Pugh. Without their skill in research and writing, this paper would never have come to completion.

Table of Contents

List of Figures

List of Tables

Chapter One: Introduction

Effective strategies for student learning have changed dramatically in the past 20 years. For example, children experience a much higher degree of technology use at a much earlier age (Richtel, 2012). In addition, the need for a scientifically literate population has become even more important through an increase in jobs requiring a foundation in science, mathematics, and technology, and the need for an understanding of basic science knowledge for all persons as they deal with everyday decisions about critical issues ranging from politics to health care. As a result, science education has come under scrutiny (Next Generation Science Standards [NGSS], 2013). The inability of many students to solve problems and think analytically has been identified as a significant problem (Hunter, 2014). To effectively teach and learn these skills, methods, and understanding, it is important for students to participate in science with a high degree of motivation and engagement on an authentic level rather than merely memorizing facts about it and surviving the required courses (Caine, 2004; Rivera, 2010; Shumow, Schmidt & Zaleski, 2013). Therefore, it is critical that teachers provide an environment where motivation can be nurtured and enhanced (Rivera, 2010).

Introduction to the Problem

In the past decade educators have been especially concerned with standards, essential outcomes, and high expectations and have spent copious amounts of time on these endeavors. Tests have been written and rewritten by companies hired by the states to determine whether these essential standards are being met and whether schools are doing the job for which they are charged (Minnesota Department of Education [MDE], 2016; National Research Council [NRC], 2012; Next Generation Science Standards [NGSS], 2015). However, throughout this process, few have asked whether students are interested or even willing to participate in the process. Although the tests are considered high stakes for educational institutions, they are not required for high school graduation (MDE, 2017; NRC, 2012). Although important for accountability, dissecting the components of science into standards may have little intrinsic motivational value to many students and often limits enthusiasm in teachers (Armstrong, 2013). As much as attempts are made to raise the bar by teaching and testing the standards, a test alone is not going to ensure that learning has taken place (Armstrong, 2013).

According to Kohn (2011) and Boaler (2016), the presence of tests and grades in classrooms may in fact limit learning as they motivate in a primarily extrinsic way rather than developing intrinsic motivation in students. When students are continually worried about tests or grades in courses, they are frequently less willing to risk success by attempting difficult problems and challenging assignments. They fall into a pattern of extrinsic motivation for learning designed to succeed in the short term but fail to engage in the long-term learning process (Kohn, 2011). This results in a decrease in internalized learning and therefore a decrease in higher order thinking (Boaler, 2016; Kohn, 2011).

However, Pittinsky and Diamante (2015) also argued that teaching strategies sometimes rely on intrinsic motivation too heavily and then fail to teach the motivation that is necessary when the work becomes more difficult and seems to be a lot less like fun. In their view, students must learn to persevere and overcome the challenges of hard work and struggle to get the end reward. Often, the motivation that perseveres in these cases is more extrinsic than intrinsic. Students persevere because they want to do well in school or earn a well-paying and/or successful career in the field of study. They may wish to impress their teacher or friends or parents. These forms of extrinsic motivation may be just as important as intrinsic motivation in achieving goals and success (Pittinsky & Diamante, 2015).

Background of the Study

Human beings are driven to satisfy three psychological needs described by Froiland, Oros, Smith, and Hirchert (2012). These psychological necessities include the need to develop competence, the need for relatedness or meaning, and the need for autonomy or control over one's own actions. To effectively learn, it is critical that learning opportunities are enjoyable, interesting, and relevant to one's personal situation (Caine, 2004; Froiland et al., 2012).

According to Gregory and Kaufeldt (2015), there are seven primary emotional networks. These include Seeking/Expectancy, Fear, Rage, Lust, Care, Grief, and Play. These are instinctive systems of motivation. The authors have labeled Seeking/Expectancy as the most powerful of these. Seeking/Expectancy includes curiosity, interest, foraging, anticipation, and craving.

A problem that has surfaced in education during the last several decades has been "the gap" in educational success between differing groups of students (NRC, 2012; NGSS, 2013). Although the possibility that student efficacy, or the belief in one's own ability to learn, has been cited as a possible cause, there is also the suggestion that perhaps motivation to succeed is a part of this issue. As student motivation is analyzed, it becomes apparent that motivating forces are not the same for all students (NRC, 2012). The reasons are very complex, but two key areas have been identified. These are the opportunity for engagement and a student's own personal motivation and meaning as related to their life, goals, and experiences (NRC, 2012). To teach in a diversified classroom, it becomes increasingly important to understand and increase individual student motivation to learn (NRC, 2012; NGSS, 2013).

Student motivation takes several forms and usually a student is motivated by one or more of these forms at the same time. The first form includes intrinsic motivation in which a student is authentically interested in the material and learns because they find it rewarding on a personal level. Students who have high levels of intrinsic motivation frequently succeed in learning and are more likely to retain the ability and skill to use the material in the future (Boaler, 2016; Kohn, 2011). The second type of motivation is extrinsic motivation. According to Aydin et al. (2014), this type of motivation occurs in two forms. One form is career motivation and one form is social motivation. In career extrinsic motivation a student wishes to do well to advance and compete for such tangible commodities as jobs, postsecondary school placement, and scholarship. In social extrinsic motivation the student wishes to do well to impress other people. Although success is possible with extrinsic motivation as the primary reason for learning many times the learning that takes place is temporary and is not as deeply authentic as that found in primarily intrinsically motivated students (Boaler, 2016; Kohn, 2011). However, it may be that a balance of both intrinsic and extrinsic motivation is most effective. Pittinski and Diamante (2015) suggested that, although intrinsic motivation is important, extrinsic motivation is also important and may play a deeper role when learning is more challenging and is no longer as enjoyable as it may once have been. The final type of motivation described by Aydin et al. (2014) is called atrinsic motivation. In atrinsic motivation, the student is not interested in learning the material. The reasons for this are often quite complex but, learning is generally not very successful (Aydin, 2015).

Once positive student motivations are identified and ignited, only then can proper interventions and teaching strategies be undertaken to make learning effective, enjoyable, and worthwhile with the goal of authentic learning and the ability to apply that learning later and in different circumstances (NRC, 2012; NGSS, 2013).

Statement of the Problem

The need for further research on high school science academic success and engagement and the influence of student motivation on learning was identified. Researchers have noted that student motivation is essential for learning to take place (Aydin, 2015; Shumow et al., 2013). The factors that affect a student's motivation to learn with resulting increases in successful engagement and intellectual growth need to be established (Schweinle & Helming, 2011). Motivational factors that lead to continued future interest and study in science, and the possibility of a career in the field need to be identified and encouraged to effectively attract prospective students and encourage them to solve complex world problems. Shumow et al. (2013) indicated that laboratory activities, relevant content, and inquiry-based problem solving improve student motivation, engagement, and learning but there is minimal research in how these activities apply as new reforms and standards in education have changed the landscape of education (Shumow, et al., 2013). The Next Generation Science Standards (NGSS) initiative seeks to understand and connect these areas of concern with an emphasis on disciplinary core ideas, science and engineering practices, and crosscutting concepts (NGSS, 2013).

Purpose of the Study

The purpose of this study was to find correlations between teaching strategies and styles and types of motivation in students that result in deeper and more authentic learning. Additional problems included the questions of whether these types of motivation are influenced by gender, identified ethnicity, and socioeconomic status. Also, does a correlation exists between motivational type and success as defined by the Minnesota Comprehensive Assessment in Science? Although the Minnesota Comprehensive Assessment in science is a low stakes exam for students and may not truly measure all knowledge in biology, it is frequently an indicator of whether a student is inspired to do well. Once successful motivational factors are identified, curricula and teaching strategies can be targeted that help to make learning relevant for each child so they can achieve at their greatest potential.

Rationale

Motivation takes a variety of forms involving factors that are both intrinsic and extrinsic in nature. These factors play a role in student efficacy, resulting in tenacity and purpose (Duckworth, 2016; Dweck, Walton & Cohen, 2014). The intrinsic sources of curiosity, wondering, and resulting motivation to look at and observe a problem are those that are reported to be frequently responsible for academic success in science and a subsequent desire to pursue further education and participation in the field (Dweck et al., 2014). These intrinsic sources of motivation and inspiration are complex and are influenced by the gender, the culture, and experience of the child, the type of science that is being studied, and the way that it is being studied. They may also involve the specific relationship with both the teacher and other students in the room. Motivation to learn can be greatly influenced by the teaching style and the relevance the student identifies in the topic (Aydin, 2015; Boaler, 2016; Dweck et al, 2014).

There are also many extrinsic factors that play a role in the process of learning. Although extrinsic factors alone such as grades or pay may have temporary positive results, they may also result in student stress and frequently less long-term learning and inspiration due to a hesitation to take risks in learning (Boaler, 2016; Kohn, 2011). However, properly inspired, they are also the types of motivation that can help a student persevere when learning becomes more difficult (Pittinsky & Diamante, 2015). Once identified, an understanding of motivational factors can influence teaching strategies. The most effective strategies can be emphasized to increase relevancy and ultimate academic success. Academic success can be identified by deep learning and the ability to make connections and solve problems as students think at higher levels of complexity. Teaching strategies may alter motivation in such a way that students find more meaning in their study and learn more effectively. Identifying the motivating factors and strategies that enhance learning for students is paramount to good teaching. Most importantly, tapping into these motivating strategies encourages real learning and the ability to creatively solve problems (Boaler, 2016; Dweck et al., 2014).

Research Questions

Five research questions were examined in this study.

RQ1: What if any correlation exists between the type of motivation style reported by students and the type of biology instructional method (traditional high school biology, honors level traditional high school biology and high inquiry-based honors biomedical science) they have experienced in high school?

RQ2: What if any correlations exist between motivation style reported by students and gender after the high school biology course experience?

RQ3: What if any correlations exist between motivation style reported by students and identified ethnicity after the high school biology course experience?

RQ4: What if any correlation exists between motivation style reported by students and socioeconomic status as defined by the qualification for free or reduced-price lunch after the high school biology course experience?

RQ5: What if any correlation exists between motivation style reported by students and success in learning biology as measured by the Minnesota Comprehensive Assessment in Science?

Significance of this Study to the Field of Education

Several authors have correlated the motivation of students with success (Dweck et al., 2014; Schweinle & Helming, 2010). Researchers have also studied the motivational aspects of teacher relationships, homework assignments, and relevancy on learning (Hunter, 2014; Planchard, Daniel, Maroo, Mishra, & McLean, 2015; Robinson & Ochs, 2008). In these studies, the overwhelming conclusion was that student motivation had to occur before success in academic learning.

The proper motivation is critical to successful learning (Aydin, 2015; Rivera, 2010). Without intrinsic motivation to learn students merely memorize facts to survive the next assessment. These facts are forgotten in short order and never become truly internalized as a part of their world view (Boaler, 2016; Rivera, 2010). Study in motivation is paramount to the study of learning. If students are merely going through the paces of education, no learning truly takes place (Aydin, 2015; Rivera, 2010). Pittinsky and Diamante (2015) argued that although intrinsic motivation is powerful to stimulate interest in any field of study, hard work, and perseverance or grit, as described by Duckworth (2016), are needed to complete the job. At this point, extrinsic motivation may play a role as students find success regardless of the obstacles in their way (Pittinsky & Diamante, 2015).

Motivation is intimately tied to a concept described as grit by Duckworth (2016). Grit is the ability to persevere and to persist with passion toward a goal regardless of setbacks. To develop grit a student must develop motivation to learn and relentlessly pursue the goal they are attempting to accomplish (Duckworth, 2016). This motivation is frequently of both intrinsic and extrinsic origin (Pittinsky & Diamante, 2015).

If education is to be effective it must take into consideration not only the cognitive aspects of learning but the affective or emotional ones as well (Aydin, 2015; Rivera, 2010). The emotional aspect of student motivation is dependent on many variables. Included in these variables are gender, culture, experience, and student efficacy or a belief in their own ability to learn (Boeler, 2016; Rivera, 2010). For several decades, there has been an achievement gap that has been identified within socioeconomic levels (NRC, 2012). To close this gap, it is necessary for all students to have success in education and to be prepared and ready for life's opportunities and challenges. Therefore, it is important that student motivation and the affective aspects of education be addressed. The affective aspects of teaching include those fueled by emotional connection to the material that is being learned (Froiland, Oros, Smith, & Hirchert, 2012; Rivera, 2010). With the advent of testing, the affective aspects of teaching may have all but disappeared in favor of the cognitive aspects (Rivera, 2010).

The National Board for Professional Teaching Standards (2016) has five core propositions that are critical to certification as National Board-Certified Teachers. The very first proposition is titled "Teachers are committed to students and their learning."

> Accomplished teachers base their practice on the fundamental belief that all students can learn and meet high expectations. They treat students equitably, recognizing the individual differences that distinguish one student from another and taking account of these differences in their practice. They adjust their practice based on observation and understanding of their students' interests, abilities, skills, knowledge, language, family circumstances, and peer relationships. They view students' varied backgrounds as diversity that enriches the learning environment for every student.
>
> Accomplished teachers understand how students develop and learn. They consult and incorporate a variety of learning and development theories into their practice, while remaining attuned to their students' individual contexts, cultures, abilities, and circumstances. They are committed to students' cognitive development as well as to students' ownership of their learning. Equally important, they foster students' self-esteem, motivation, character, perseverance, civic responsibility, intellectual risk taking, and respect for others.
>
> (National Board for Professional Teaching Standards [NBPTS], 2016, p. 8)

As exemplified by the National Board of Professional Teaching Standards, motivation is important for student learning and teachers are charged with fostering the development of motivation. How students differ in motivation is critical as it can influence the learning of groups of students who may be underserved in the current system (NBPTS, 2016; NRC, 2012).

The National Board of Professional Teaching Standards make it clear that motivation is important for learning to occur and successful teachers work to foster motivation in their students through their knowledge and understanding of the child they are teaching. It is assumed, based on the research by Aydin, (2015), Dweck et al., (2014), and Rivera (2010), that intrinsic motivation is a more powerful influence on learning than other forms of motivation. However, Pittinger and Diamante (2015) also pointed out that extrinsic motivation plays an important role in the learning process as students move through the more difficult areas of learning on their way toward success and accomplishment.

Definition of Motivation Types

Motivation can be classified as extrinsic, intrinsic, and atrinsic. "Extrinsic motivation" is motivation that is focused on a tangible reward. According to Aydin (2015), extrinsic motivation can be divided into two main sub categories entitled "Social Extrinsic Motivation" and "Career Extrinsic Motivation". Social extrinsic motivation is motivation that centers on how the student is perceived by others (Aydin, 2015). Students who are motivated by Career Extrinsic Motivation are often those students who work hard in school because they wish to be competitive as they try to access a career path. This is often evident in students who are pursuing careers perceived by society to be prestigious and high paying (Aydin, 2015).

"Intrinsically Motivated" students are the ones who authentically love to learn. They learn for the joy and interest in the material they are learning. They are often inquisitive and creative as they fearlessly question the material and concepts they are exploring. Their personal performance is not as important as the pursuit of the knowledge. For these students, learning is an endeavor they do because they find it rewarding at a personal level. They have less fear of failure and are not afraid to try something new or unique even though they may not always succeed (Aydin, 2015; Boaler, 2016; Kohn, 2011).

Students who are not motivated are described as "Atrinsic" by Aydin (2015). These students do not see the point of attending school or taking classes. The reasons for this may be quite complex but the result is that the students do not show interest or inclination to engage in learning (Aydin, 2015).

Student motivation is frequently a combination of intrinsic, extrinsic, and sometimes atrinsic motivation. The balance between these types of motivation affects the learning that takes place for each child. According to Aydin (2015), when the balance favors intrinsic motivation, more authentic learning has been observed.

For the purposes of this study, MCA exams will refer to the Minnesota Comprehensive Assessment given in the spring of each year by the Minnesota Department of Education for assessing the state science standards in nature of science and engineering and in life science. The test is given at a time chosen by individual school districts after the student has taken their biology course which fulfills the standards for life science.

Assumptions and Limitations

Although it is recognized that prior life experience and previous school experience can play a big part in motivating students, for this study the concentration will be on the effect of the high school experience. If, regardless of previous school experience, students show a higher level of positive motivation following one high school biology course, then it is possible that this course offering, and teaching strategy associated with it may have made a significant contribution to that state of mind or that this course offering has attracted a student who is more positively motivated in this area. It is acknowledged that some high school programs will inherently attract certain groups of students with differing types of motivation and background.

This will be a variable in the study that is not possible to control but is fully acknowledged and appreciated. However, with the high numbers of students involved, effective teaching strategies may be identified that are correlated with higher motivation and may be assumed to influence it or at least to support it.

According to reliability and validity results, the Minnesota Comprehensive Assessment (MCA) was determined to be a fair assessment of learning (MDE, 2017). This test was intended to assess the Minnesota Standards in Science in the areas of nature of science and engineering and life science. The test, which is taken in the spring of each year, is a computer-based test with graphical representations and illustrations that attempt to determine the basic knowledge and reasoning acquired by a student during their high school biology class. They are often considered high stakes for the school system or district. The MCA test provides an opportunity to compare all students on a similar scale and assess knowledge based on the Minnesota Science Standards (MDE, 2017). However, since passing scores on the MCA exam are not required for high school graduation and since there is no personal reward or consequence for the student who is testing, they are often low stakes tests for students. It is acknowledged that student learning may not be the variable that is measured. Rather, the willingness to comply with the test in conjunction with the knowledge learned is the actual result of this assessment for the individual student.

Limitations of this study include the fact that students may have had different teachers for their required standards-based biology course. Therefore, the exact relationship with the teacher may have varied from student to student. Due to the written formal curriculum, the class content should have been similar. However, every class construct and mix are slightly different depending on the student mix and the teacher involved. There may have been some uncontrolled variables in diversity, experience, and culture within the classroom. The time of day that the class took place may also have played a role in motivation as perceived by the student (Burton, 2007; Randler, Rahafar, Arbabi, & Bretschneider, 2014). Although teachers coordinated grading and curriculum, there may still have been minor differences in grading, enthusiasm, gender, age, and teaching style of the teacher. In addition, some classes attracted more initially motivated students than other classes. For example, honors classes traditionally attract students with higher degrees of motivation to work hard and succeed in the course for a variety of reasons (Lyman & Luther, 2014).

This study took place in a moderately large Midwest town with a strong medical community. As such, the social pressure to study science, and especially biomedical science, may be stronger than that found in other school districts. This pressure may have had either positive or negative connotations depending on the personal experiences of the student.

Nature of the Study

This study was quantitative in nature. High school biology students were surveyed to identify their proportional motivational style and types. This was done in the spring after the required standards-based biology course and after the Minnesota Comprehensive Assessment (MCA) for science. Motivation was correlated with the type of biology course students had taken (traditional honors biology versus traditional regular biology versus high inquiry honors biomedical science) and with academic success as identified on the Minnesota Comprehensive Assessment in science. Differences in correlation with gender, identified culture, and socioeconomic status were measured.

Organization of the Remainder of the Study

A literature review is included in Chapter Two followed by the detailed methodology used in the study in Chapter Three. Chapter Four includes an examination of the results and Chapter Five discusses conclusions, implications, and recommendations based on the outcome of the study.

Chapter Two: Literature Review

History of Human Learning and Education

Learning is and has always been an important human endeavor. Evolutionarily it was the ability to learn and advance collective knowledge that enabled humans to succeed in hostile environments on planet Earth (Gray, 2008). However, the way that they are taught and asked to learn has changed dramatically over the years humans have resided on earth. Through the nearly two million years that humans have been on this planet in one form or another, learning has evolved from experiential learning in which survival was dependent on observation, exploration, and the passing of knowledge from one generation to the next to formal learning taking place in a classroom with a teacher at the front (Tokuhama-Espinosa, 2016).

Children are born with an "innate curiosity" (Moulding, Bybee, & Paulson, 2015; Tokuhama-Espinosa, 2016). They explore their environment through any means available using all their physical senses. Curiosity is the emotion that ultimately fuels this exploration of the environment, resulting in reason and knowledge learned through observation and analysis. Exploration, observation, and reasonable analysis are the ways people make sense of their world (Moulding et al., 2015). Remembering and applying the resulting learning to new situations is the way they have survived and prospered (Moulding et al., 2015).

Historical and evolutionary research indicates that humans initially survived as hunter-gatherers (Groeneveld, 2016). In this capacity the best survival strategy was to continually explore and observe the natural world around them, discover information about it, and then use this information in creative ways to find food and shelter. When human beings first started wandering the planet, they spent their time fishing, hunting, and gathering plants. During this time, they developed instincts based on curiosity and the desire to explore new and unique situations with trial and error as their compass. The formation of social alliances and cooperative learning and working also evolved as an effective survival strategy. About 8,000 B.C. (10,000 years ago), the process of agriculture began, and the time of the hunter-gatherer ended (Groeneveld, 2016).

During the time of the hunter-gatherer, as humans wandered throughout the world, there were no distinctions between work and play. Children were naturally driven by an innate desire to explore and learn through play. This desire was fueled by curiosity and they were given unlimited freedom to follow it because that was the most reliable method for discovering new food and shelter sources (Gray, 2008). After hundreds of thousands of years of experiential and applied learning through the channels of curiosity, the relatively recent change to formal mass learning is a far cry from evolutionary roots (Tokuhama-Espinosa, 2016). With the advent of agriculture, children were no longer permitted to freely wander and explore as they learned. Instead they were required to do agricultural work which was often tedious, repetitive, and labor intensive in nature (Gray, 2008). Children moved from the freedom to explore into essentially controlled servitude as their survival depended on their own hard work and the good will of whoever owned the land on which their food was grown (Groeneveld, 2016). Play was considered bad and the natural instincts of children to explore through play was purposely and methodologically suppressed or limited (Gray, 2008; Groenveld, 2016). With a focus on the spiritual and religious aspects, it was deemed necessary that all humans learn to read to understand the scriptures (Gray, 2008). Therefore, formal educational institutions were mandated and were considered the “work” of the child (Gray, 2008).

History of Science Education

In 1893, under appointment by the National Education Association (NEA), the Committee of Ten was convened under the direction of Charles Eliot, president of Harvard University, to determine curriculum standardization for public high schools (Mirel, 2006). Their report dictated a liberal arts education philosophy for public high schools in which all students were required to take a college preparatory curriculum including a sequence of biology, chemistry, and physics in the sciences (Mirel, 2016). Education was intended to prepare children for college, if they wished to go, and to be productive citizens in a democratic society. Although they did institute the concept of some choices in the form of electives for students, the committee advocated for equal education for all students regardless of their ultimate goals in life (Mirel, 2016).

In 1918, the National Education Association (NEA) commissioned a reorganization of secondary schools. Their recommendations included seven goals for all students. These were the study of health, construction of fundamental process, worthy home membership, vocation, citizenship, worthy use of leisure time, and ethical character. In 1924 a committee on the Place of Science Education, which was part of the American Association for the Advancement of Science (AAAS), was formed. This committee stressed the importance of scientific thinking as a goal (Osborne, 2017).

During World War One and World War Two, the need for practical science was deemed highly important, but following these wars, interest in science education waned. When Russia launched Sputnik in 1957, everything changed again. The United States was embarrassed that Russia had succeeded before they did, and science education became increasingly important.

The National Science Foundation was formed and much of their recommended curricula focused on increased science education. However, this science curriculum was often too discipline-oriented, theory-based, not connected with other parts of the education curriculum, and often too difficult for the average student (Osborne, 2017).

Following this increase in science importance in 1958, the Biological Sciences Curriculum Study (BSCS) was conceived. This study approached science from a different venue. Originally begun for gifted students, it quickly spread to all students. The model consisted of what was called the "5E" approach in which engagement, exploration, explanation, elaboration, and evaluation were addressed. A constructivist view of learning was proposed in the "5E" curriculum. Learning was based on past student experiences and built on the use of new experiences, so students could assimilate a holistic view of the concepts that would be retained for future use (Bybee, Taylor, Gardner, Van Scotter, Powell, Westbrook, & Lades, 2006).

In 1983, the report *A Nation at Risk* was unveiled by the federal government (U.S. Department of Education, 1983). The basic premise was that the United States was not keeping up with the rest of the world. The view of the committee was that the current education system needed to be improved. Changes were implemented for all students to be educated, progressive, and capable. The report stated the following:

> All, regardless of race or class or economic status, are entitled to a fair chance and to the tools for developing their individual powers of mind and spirit to the utmost. This promise means that all children by their own efforts, competently guided, can hope to attain the mature and informed judgement needed to secure gainful employment, and to

manage their own lives, thereby serving not only their own interests but also the progress of society itself (p. 1).

Following this report, education in general and especially science education was once again under scrutiny and in the process of undergoing change with standards and increased interest in the process of inquiry and discovery (Osborne, 2017; U.S. Department of Education, 1983).

In 1996, the National Academy of Sciences published the National Science Standards. The changing emphasis aligned strongly with inquiry-based teaching strategies. The standards focused less emphasis on getting an answer, learning skills outside of their context, and coverage of large amounts of material. Now the emphasis was on using multiple process skills to investigate and analyze science questions. Students were asked to communicate their findings and question and defend conclusions by applying the results of the experiments (Herr, 2007).

With increases in understanding how students learn and as new areas of science knowledge and skills unfolded, a call for a new model of science standards went out.

The 2012 model for science education was exemplified in *A Framework for K-12 Science Education; Practices, Crosscutting Concepts, and Core Ideas* (NRC, 2012). The Next Generation Science Standards was the most recent revision of this work (NRC, 2012). The Next Generation Science Standards called for a three-dimensional approach to K-12 science education. Included in the dimensions were disciplinary core ideas (content), scientific and engineering practices, and cross-cutting concepts. The scientific and engineering practices and the cross-cutting concepts were intended to be taught within the content rather than separately as may have been done in the past (NGSS, 2013). The focus was on a smaller set of core standards that were coherently connected from grade to grade. The interpretation of the term inquiry used in previous standards had caused confusion. Therefore, the intent of the term inquiry as used in NGSS standards was the notion that students will actively engage in the practice of science and not simply learn about it from another source (NGSS, 2013). The National Science Teachers Association (NSTA), in its position statement published in 2004, had described inquiry as central to the learning of science with an emphasis on asking questions and a de-emphasis on a prescribed methodology for finding answers. The new set of standards expanded and clarified the use of inquiry. Students were asked to be skeptical and to make decisions based on evidence (NGSS, 2013; NRC, 2012). This engagement embodied the full range of cognitive, social, and physical practices that are needed to "do" science. Inquiry was contrasted with engineering. In inquiry a question is formulated and can be answered through investigation. In engineering a problem is formulated that can be solved by design. Content alone is merely memorization while practice alone is merely activity. By coupling practice with content, true meaning can be made of both as students reflect on what takes place in science and engineering in the real world (NGSS, 2013).

However, at most high schools, students continue to take six or seven classes in which they enter a room for 50-60 minutes, listen to a teacher, take notes or do laboratory exercises, and then repeat. It may often be difficult to have deep discussion or involved laboratory exploration. They have a short time for lunch and then they end their day. Although this is in sharp contrast to the recommendations by the organizations who advise science educators, it is frequently necessary due to budget constraints and logistics. The current system is also not at all like the way human learning evolved in the time of the hunter gatherer. Through much of human history prior to the advent of agriculture, learning was done because it was necessary for survival and for human cooperative understanding. If learning was not successful, as happens in all types of natural selection, life usually ended tragically. In both curiosity-fueled experiential learning and learning for survival, the learning was continuous and had powerful, emotionally charged motivational forces (Tokuhama-Espinosa, 2016). Formal education, if it happened at all, was a special opportunity that was often only available to a select few or had spiritual significance (Tokuhama-Espinosa, 2016). A return to the coupling of practice with content and the formulation of questions with experimentation or problems with design is much more like the world for which humans evolved prior to agriculture and formal learning. Solving problems within the context of active participation is a method honed by millions of years of evolution and as such, has a strong chance of success in learning (Tokuhama-Espinosa, 2016).

Natural human curiosity and an innate quest and desire for knowledge occur early in a child's life (Moulding et al., 2015; Rivera, 2010) just as it did since the beginning of human evolution (Gray, 2008). Unfortunately, in the current system, natural curiosity is often curtailed and diminished as students enter and continue in school (Gillet, Vallerand, & Lefreniere, 2012; Gray, 2008; Rivera, 2010).

Current Educational Model and Science Education

Since the early-mid-20th century, formal education has been the norm. With this norm came many changes to human learning and perception of that learning from the evolutionary roots of human beings. It is common for students to spend at least 12 years in a formal classroom with many students spending additional years based on their choice of career. Formal education ends at approximately age 18 or after 12 years of schooling post-kindergarten. Although it varies by state, compulsory education usually ends at age 16 (Corsi-Bunker, 2018).

Some students can adapt to this relatively artificial situation. However, it is argued that this type of learning may not always be applicable in the work force and may sometimes inhibit the ability to learn or perform informally or in a creative sense (Boaler, 2016; Hunter, 2014).

This is especially true in the field of science and is why those involved in science education have recently put forth much effort to support teaching inquiry as opposed to information learned strictly from the pages of a textbook (Boaler, 2016; Hunter, 2014; NGSS, 2013). With the advent of the Next Generation Science Standards, the process of inquiry has been modified to include engineering processes as well (NGSS, 2013).

In the middle ages in Puritan America, education was considered a method of inculcation (Gray, 2008). Educational institutions were indoctrinating students with ideas and knowledge that was pre-ordained. Education was based on memorization of facts and children were encouraged to be obedient and accept what was told to them without questions (Gray, 2008). However, science does not fit into this mold. Science is based on theory and although there is a plethora of evidence to support them, they are still subject to change and adjustment when new technology and the resulting data dictate that the theory needs adjustment (Bowman & Govett, 2015; Minnesota Department of Education Science Standards, 2009; NRC, 2012).

According to Taylor (2014), student learning in the traditional model may not be taking place on a deep enough level to allow students to transfer knowledge when they encounter new, novel situations and problem-solving tasks in advanced education and careers. Taylor (2014) studied students who attended a network of schools that focused on deeper learning concepts including project-based learning and problem-solving skills, student collaboration, and real-world relevancy. The results of the study indicated that students scored significantly higher on the Organization for Economic Cooperation and Development (OECD) Program for International Students Assessment (PISA) test in reading, mathematics, and science, and that students reported higher levels of academic engagement, motivation to learn, self-efficacy, and collaboration skills when attending these schools (Taylor, 2014).

To teach effectively, models of learning were developed in the early 20th century. These models included such methodology as seen in the "constructivist theory" described by John Dewey (University College Dublin [UCD], 2017). The constructivist theory argued that the student should be placed in situations in which they can draw out understanding from their previous experience. Students need to be engaged in real world problem solving in order to learn. In actual application however, Vygotsky (1934) emphasized the role of culture and language in the assimilation of knowledge as described by the "Social Constructivist Theory". His argument was that people learn with meaning and relevance in mind and not just attention to fact (UCD, 2017).

Implications for the Achievement Gap

As schools have become more diversified with the advent of immigration and cultural mixing, the way that students learn and their motivation to learn may greatly affect their opportunity to learn. In recent years, achievement "gaps" has been identified (Huang, 2015; NGSS, 2013; Picho & Stephens, 2012) between socioeconomic groups of children. The question proposed by Huang (2015) became whether the current method of education is appropriate for all students in all groups or does it cater to one type of student over others? Additionally, is that student who is most successful in the current education system going to be the one that is most capable of succeeding in life beyond formal education? Will this student be able to go on to create and develop new ideas and to solve real life problems facing themselves and society in general (Boaler, 2016; Huang, 2015)?

Some students have scored consistently and significantly in the bottom 10% of the student population on standardized tests. One group that has been affected is students of African descent (MDE, 2015; Mosweunyane, 2013; NGSS, 2015; Picho & Stephens, 2012). Other groups that have been identified as needing additional thought and attention are: economically disadvantaged students, students from several other major racial and ethnic groups, students with disabilities, and students with limited English proficiency (Gassama, 2012). In addition, girls, students in alternative education programs, and even gifted and talented students are identified as needing additional support and/or purposeful style (Cheryan, 2017; MDE, 2015; NGSS, 2015; Spearman & Watt, 2013).

Surprisingly, a group of students who are unpredictably struggling are girls who have grown up affluent (Lyman & Luther, 2014; Wardle, Robb, & Johnson, 2017). In a study by Lyman and Luthar (2014), two groups of students were compared as to their level of anxiety and perfectionism. Both groups were academically competitive except that one group was from an expensive and exclusive private school and the other group was from a magnet school in which most students would be considered economically disadvantaged. On a scale to explore the adverse consequences of perfectionism including mental issues, academic success, and substance abuse, the students who were considered affluent had the most negative outcomes. Of these outcomes, girls were reported to be most affected. In this case, high pressure and expectations from parents and especially their mothers were implicated as the most debilitating factor in the lives of these students and consequently affected student motivation detrimentally (Lyman & Luthar, 2014).

It is interesting to note that while some groups score below the mean on standardized tests, other groups are scoring above the mean. One group scoring high are Asian students and particularly those of Chinese heritage. To understand the gap, it may be necessary to look at the motivation of students on both ends of the spectrum. Students of Asian heritage have repeatedly scored high on standardized tests. This finding may be reflective of a very different culture and belief system surrounding education. Levinsohn (2007) reported that Western students typically believed that academic success was related to innate ability or a given talent such as IQ while Asian students believed understanding and academic success was attributed to effort. This view of learning promotes strict attention and serious study which is frequently reflected in test scores and other measures of academic success. However, it may also promote self-shame and blame if the student fails. When the Western student fails, the blame is placed on factors beyond the child's control. In the Asian culture, the blame is placed squarely upon the shoulders of the child (Levinsohn, 2007).

Children living in poverty have been reported as doing poorly on standardized tests and learning in general. Their challenges are greater and their opportunities to learn are often fewer than other children. Blair (2012) reported that levels of stress hormones such as cortisol appear to influence the brain circuitry development of children. Stress factors that increase cortisol levels, resulting in disruption in brain development, include such things as financial worry, crowded conditions, and lack of child care. These factors are frequently seen affecting children who live in poverty (Gassama, 2012; National Institutes of Health [NIH], 2012).

In a world of critical real-life problems, no brain can be left untapped and all must be encouraged in creative problem solving both within their chosen fields and outside of them (NRC, 2012). According to the National Research Council (2012), it is of utmost importance that diverse groups of people are involved in the study of science. Each group brings unique perspective to the field and society cannot afford to exclude any of them. To do this, it is necessary to determine the best way to motivate each student to learn so that increased human productivity can be accomplished and all talents can work together to solve the issues inherent in our scientific, social, and political realms (Huang, 2015; NRC, 2012).

Motivating all students to learn is essential. Factors that need to be taken into consideration which may affect motivation include opportunity, stress, cultural expectations, gender expectations, peer pressure, and parent support among others (Rivera, 2010). Without the appropriate motivation to learn through understanding, students merely memorize facts to survive the next assessment. These facts are forgotten in short order and never become truly internalized (Boaler, 2016; Rivera, 2010). Study in motivation is paramount to the study of learning. If students are merely going through the paces of education no learning truly takes place (Caine, 2004; Rivera, 2010).

Hierarchy of Learning

As early as Gardner's (1991) work on Multiple Intelligences and Maslow's (1954) hierarchy of needs, the affective domain of learning has been recognized as critical. With the advent of No Child Left Behind signed into law in 2002 by President George Bush (U.S. Department of Education, 2018), the affective domain has taken a back door to the cognitive domain (Walker, 2014). Students are taught that there are standards they must know, and learning has become a prescribed set of topics rather than immediate problems needing contemplation and invoking curiosity and wonder (Walker, 2014). For example, students were often given lists of "essential facts" that they must know before they take their state tests, or they were quizzed on the "facts" on a weekly basis (Walker, 2014). Although this was not the intent of the standards writers, it was reported in a National Education Organization survey that this was true for almost half of all teachers out of 1,500 K-12 teachers that were surveyed by the National Education Association (Walker, 2014). For many teachers, their reputations were based on the success of their students when tested on these standards (Walker, 2014). Instead of embracing the standards for depth and understanding, incorporating them into their teaching, and making real life connections, they concentrated on facts, as they believed this was the best way to survive these tests. Albeit, a 3-hour test, even when it is scenario based, is a poor excuse for addressing the standards as they were intended. However, with the constraints of the current system, this was what was offered in a world where politicians were demanding teacher accountability (Walker, 2014).

No Child Left Behind (NCLB) was replaced with Every Student Succeeds Act (ESSA) signed by President Obama on December 10, 2015. ESSA was intended to be more workable for schools and teachers than the No Child Left Behind law. In many ways, however, it was like No Child Left Behind in that there is an emphasis on the importance that every child must learn, that schools will be held accountable for that learning and the best way to measure this is through testing. The difference is that now the focus is more deeply concerned with equity and preparation for all children to succeed in college and career (U.S. Department of Education, 2017).

Affective Domain in Learning

Rivera (2010) described a problem in education where testing had influenced education so much that the cognitive element was emphasized, and the affective domain was all but ignored. With the advent of high stakes multiple choice testing, student motivation and especially intrinsic motivation has decreased due to a failure to connect with the emotional and relationship elements of education (Rivera, 2010). As administrators and teachers stress repetition, content, and drill, they are attempting to develop students' cognitive skills and are often ignoring their affective skills. Rivera (2010) suggested that teachers who are capable of teaching content while practicing affective teaching techniques will be more effective. When educators disregard the affective domain, they fail in an important part of teaching students (Rivera, 2010).

According to Panksepp and Biven (2012), who studied the emotions of mammals, there are seven primitive emotional processing systems. These systems include basic raw emotions that are frequently instinctual and often overlap with each other such as: Seeking (expectancy), Fear (anxiety), Rage (anger), Lust (sexual excitement), Care (nurturance), Panic/grief (sadness), and Play (social joy). They described the Seeking system as the most important of all systems. The Seeking emotions allow mammals to find and anticipate the things they need to survive and are necessary to experience many of the other emotions. In the classroom, the Seeking system is the one that initiates learning, curiosity, and interest. When the Seeking system is adequately activated, students become involved in the process of searching for knowledge, solving problems with it, and ultimately retaining it in memory for use in future problem solving (Boeler, 2016; Gregory & Kaufeldt, 2015**)**. When these areas of the brain (nucleus accumbens and lateral hypothalamic areas) are stimulated, all animals experience intense enthusiasm as opposed to pleasure (Gregory & Kaufeldt, 2015).

Authors have correlated the motivation of students with science educational success as measured by both tests and future involvement in science (Schweinle & Helming, 2010). Hunter (2014) suggested the use of five ideas in teaching science, which are: engaging, encouraging, exploring, explaining, and evaluating. The very first idea is the most critical. The engagement process involves and fuels the student's willingness and desire to participate in the learning process (Hunter, 2014). This was described by Hunter (2014) as the "anticipatory set". It is through engagement that the student becomes motivated to pursue the topic and explore it. Engagement is the method by which intrinsic motivation evolves. When students develop deep interest, that interest can fuel the motivation to continue to pursue knowledge (Hunter, 2014). This is a similar concept to the 5Es reported by Bybee (2006) in the model depicted by the BSCS curriculum.

Other researchers have investigated the motivational aspects of homework and assignments. Planchard, Daniel, Maroo, Mishra, and McLean (2015) studied the motivation of college students to do homework in a college genetics course. They found that although homework completion was directly correlated with success in the course, giving extra credit for the work did little to influence the motivation to do it. Rather it was relevancy and content that most influenced student motivation to complete the assignments (Planchard et al., 2015). Robinson and Ochs (2008) assessed the motivation of 405 high school students to pursue science courses beyond the high school requirement. They found that students wanted science courses to be taught with more labs and activities that create interest and relevancy. This resulted in increased motivation to continue learning science (Robinson & Ochs, 2008). These studies concluded that student motivation to learn, complete homework, and continue in the study of science occurred most often when the subject was relevant and interactive (Hunter, 2014; Planchard et.al, 2015; Robinson & Ochs, 2008).

Types of Motivation

Motivation takes a variety of forms involving factors that are intrinsic, extrinsic, and atrinsic in nature. These factors play a role in student efficacy resulting in tenacity and purpose (Duckworth, 2016; Dweck, Walton, & Cohen, 2014). The intrinsic sources of curiosity, wondering, and resulting motivation to carefully observe a problem are those that are frequently responsible for academic success in science, as well as other academic areas, and a desire to pursue and participate in the field (Dweck et al., 2014). These intrinsic sources of motivation fuel natural curiosity and interest. Intrinsic motivation inspires higher order thinking and is frequently responsible for the phenomena described as Flow Theory (Csikszentmihalyi, 1990). The student becomes so involved in the process of learning for the sake of learning and interest in the material that little else matters. Intrinsic motivation to learn can be greatly influenced by the teaching methodology and the relevance the student identifies in the topic (Boaler, 2016; Dweck et al., 2014).

There are many extrinsic factors that have played a role in the process of learning. Although extrinsic factors such as grades or pay may have temporary positive results, they also often result in student stress and frequently less long-term learning and inspiration. This may be due to a hesitation to take risks in learning as students see themselves in competition with other students (Boaler, 2016; Kohn, 2011). Extrinsic motivation takes a variety of forms. According to Aydin et al. (2015), one form is career extrinsic motivation, and another is social extrinsic motivation. The difference is subtle, but in career extrinsic motivation the focus is on success in participating in often competitive career goals which may involve post-secondary program admissions. In social extrinsic motivation, the focus is on how one looks in the eyes of others (Aydin, 2015). According to researchers, extrinsic motivation may be of great importance during those times when learning becomes difficult and requires hard work and perseverance. Extrinsic motivation may bridge the gap that sometimes occurs between fun and success (Pittensky & Diamante, 2015).

Aydin et al. (2015) described a third type of motivation called atrinsic motivation. In this type of motivation, the child is not inspired. These are students who have no interest in learning and do not want to participate in the process (Aydin et al., 2015). In fact, they may actively put energy into avoiding the process of learning all together (Aydin et al., 2015).

Measuring Motivation

To effectively measure motivation, Aydin et al. (2014) developed a survey aimed at determining the type of motivation and perceived level of motivation for students to learn biology. Nineteen questions were developed which measured the relative level of intrinsic motivation, extrinsic social motivation, extrinsic career motivation, and atrinsic motivation on a six-point Likert scale. Their development process included randomly selected students from five different high schools in Turkey following the completion of their biology course. The focus of the questions was on “Why do you study biology?”. The original survey was in Turkish and then later translated into English. The study population included 191 students for samples one and two which determined a reduction in the item pool and then an explanatory factor analysis with different students. The final sample of 281 students was done to determine a confirmatory factor analysis with a completely different set of data.

Internal consistency of the data was calculated with a Cronbach's alpha. Results were 0.908 for Intrinsic, 0.887 for Atrinsic, 0.846 for Extrinsic Career and, 0.715 for Extrinsic Social. This demonstrated that the results from the data set were reliable. Evidence for validity was supported with a confirmatory factor analysis (Aydin et al., 2014).

Motivation in Child Development

Gillet, Vallerand and Lafreniere (2012), studied 1,600 students with a mean age of 9-17 years. Their results provided evidence that student intrinsic motivation and self-determined extrinsic motivation both decrease with age from 9-12 years and then stabilize to age 15 when they may again begin to increase. Non-self-determined motivation showed a decrease up to age 12 and then slow stabilization. Self-determined motivation is motivation that is within the child or chosen by the child such as an interest in a career. Non-self-determined motivation is motivation influenced by such things as the expectation of passing grades by parents. Amotivation, also called atrinsic motivation by Ayden et al. (2014), was relatively low but stable from age 9-17. The study suggested that one of the main factors for changing this trend was to provide autonomy support from both parents and teachers. It was suggested that parent support is important, but teacher autonomy support has the greatest influence on student intrinsic motivation. This study demonstrated the importance of understanding motivation to create appropriate interventions to support optimal motivation to learn in all students (Gillet et al., 2012).

There appear to be different motivational factors involved for different students. Some students are motivated by independent social variables and others work interdependently and rely on social connective thought and feeling. Some students have had difficulty learning in the traditional educational model. There is evidence that this may be associated with culture and/or gender experience and ultimately affects the motivation to learn.

Gender Influence on Learning Science

Koul, Roy, and Lerdpornkulrat (2012) described the learning success and motivation to learn based on gender in physics and biology courses. Their study implied that girls were less attracted to the study of physics and more attracted to the study of biology based on perceived sex stereotypes, while boys exhibited the opposite behavior (Koul et al., 2012). Smith, Brown, Thoman, and Deemer (2015) surveyed 388 women enrolled in college level physics (male dominated) or biology (female dominated) to ascertain the effect of stereotype identity and future motivation to do scientific research. This study concluded that women were more motivated when they felt that what they were doing was useful for helping other people and society. Research indicates that women prefer studying subjects and choosing careers in areas with a high human content (Smith, Brown, & Thoman, 2015). Women perceived the study of biology as fulfilling this requirement better than the study of physics (Smith et al., 2015).

Hammer and Alphonso (2017) described the issue of female representation in science. Standardized test scores for 8^{th} graders showed that girls had closed the gap in science and math. They perform equally as well as the boys on these tests. However, participation in the science courses began to drop in high school and continued through college. This drop began in high school when peer pressure is at its greatest. This was not as severe in countries such as Turkey, India and China in which science careers were considered highly desirable. In the United States they have been more often associated with people who are nerdy or have less than optimal social skills (Hammer & Alphonso, 2017).

It has been reported that young women are greatly influenced by subjects and topics that are people-oriented and are socially relevant (Gurian & Stevens, 2004; Koul et al., 2012). They are also strongly influenced by role models and stereotypes. Cheryan (2017) explored the disparate percentages of women in the fields of engineering and computer science. Qualitative data suggested that young women were greatly influenced by the role models and images of people in these professions and that this influences their attraction to these professions. Whereas reports indicated that the physical and computer sciences appeal more to young men, the biomedical sciences appear to appeal very strongly to young women (Cheryan, 2017; Gurian & Stevens, 2004). It is also probable that some teaching strategies such as group work and facilitation are more conducive to the socially involved mind of young women at this stage of development (Gurian & Stevens, 2004).

Depth and Quality of Learning

There has been concern over the depth of student learning and the ability of students to use learning. Bloom's (1956) revised taxonomy is a well-known categorization system in which learning is divided into six categories (Anderson & Krathwohl, 2001). Although the intent is for students to work at high cognitive levels, all levels are important. The first category involves "recall". Recall is demonstrated by a student being given information and then recalling that information when it is asked for on a test. The next level is "understanding" the material followed by "applying" the material, "analyzing" it, "evaluating" it, and finally at the pinnacle, the ability to "create" it or with it. As students learn they freely move between the levels of understanding, and can work at consistently higher levels. When a student is not motivated to learn or in some cases are only extrinsically motivated, they learn at a lower cognitive level. When intrinsic motivation and positive affective domain are incorporated, they learn more authentically and can apply their learning to real world situations as well as in alternate situations at higher levels of thinking as they move easily between the levels of the learning taxonomy. As a bonus, learning becomes less like work and more like play (Gray, 2008; Schweinle & Helming, 2011).

It has been argued that there are optimal levels of challenge for the greatest learning to take place (Schweinle & Helming, 2011). If learning is too challenging, the student gives up. If the learning is too easy, the student gets bored. Motivation is assumed to be highest when there is a balance between student skills and the challenges of the tasks. This concept, described as "Flow Theory" by Csikszentmihalyi (1990) and Schweinle and Helming (2011), may also contribute to Self Determination Theory and Efficacy as described by Dweck et al., (2014). In "Flow Theory" an instructional method takes advantage of student interests and enthusiasm. Students are given choices in what they want to learn, how they want to learn it, and how fast they want to learn it. The classroom environment is created in a way that students can explore on their own terms and follow their interests. According to Csikszentmihalyi (1990), when talking about flow and happiness, "The best moments usually occur when a person's body or mind is stretched to its limits in a voluntary effort to accomplish something difficult and worthwhile. Optimal experience is thus something we make happen" (p. 3).

Another theory influencing effective and motivated learning is the theory of "Multiple Intelligences" by Gardner (1991) in which student learning styles are honored as material is shared in a wide variety of formats so each student can learn in the most effective manner and therefore increasing their motivation to learn. It is important for teachers to use a variety of formats in their classes. Gardner (1991) described eight learning strengths that he felt met these criteria. They were musical-rhythmic, visual-spatial, verbal-linguistic, logical-mathematical, bodily-kinesthetic, interpersonal, and intrapersonal (Gardner, 1983). In 1999, after discussion and reconsideration of the multiple intelligence theory, Gardner added naturalistic, existential, and moral intelligence. By teaching in a variety of ways which appeal to each or several of these learning strengths, teachers can naturally appeal to students in a way which has the greatest possibility of increasing their motivation to learn (Gardner, 1991).

For many students, attitudes and feelings toward a subject matter are a contributing factor toward successful learning. Koul et al. (2012) stressed that for students to learn effectively the classroom must be a setting where social activity is less about competition and more about interacting in cooperative activities. Social interaction, however, brings with it social problems and stereotypes associated with different groups of people. Stereotypes have been found to influence motivational goal orientation and student efficacy (Koul et al., 2012; Schweinle & Helming, 2011).

Concepts of learning mingle in the research from Caine, Caine, McClintic, and Klimek (2016) when describing the following Brain-Mind Learning Principles:

1. All learning is physiological.
2. The Brain-Mind is social.

3. The search for meaning is innate.

4. The search for meaning occurs through patterning.

5. Emotions are critical to patterning.

6. The Brain-Mind processes parts and wholes simultaneously.

7. Learning involves both focused attention and peripheral perception.

8. Learning always involves conscious and unconscious processes.

9. There are at least two approaches to memory: archiving individual facts or skills or making sense of experience.

10. Learning is developmental.

11. Complex learning is enhanced by challenge and inhibited by threat associated with helplessness.

12. Each brain is uniquely organized

Through research in the psychology of learning the evidence consistently points towards the importance of relevancy, social connection, meaning, patterns, emotions, and challenge to truly and authentically learn information, retain it, and have the ability to use it (Caine et al., 2016; Koul et al., 2012; Rivera, 2010; Schweinle & Helming, 2011).

Grading as a Detriment to Learning

Within the process of educating students, there has consistently been the need to quantitate learning as a critical part of accountability and as a measurement of individual student progress. Student grade records have been used for a variety of reasons including achievement, readiness for progression into more complex courses or topics, and competition for class placement, which can influence job opportunities and/or acceptance into post-secondary programs. Even though this process continues to have an important role in educational institutions and learning, there is evidence that grading is a detriment to intrinsic motivation (Coutts, Gilleard & Baglin, 2011; Kohn, 2011). Grading brings in the concept of competition. Students become more worried about grades than about learning. When grading based on traditional assessment, which ranks and sorts students rather than providing them with feedback, becomes the primary purpose of teaching, it may interfere with the student's ability to learn. Students fear failure so much that they are no longer willing to take risks which lead to new knowledge and most importantly the ability to create and problem solve with new ideas (Kohn, 2011).

Marzano and Heflbower (2011) advocated for a standards-based grading system in which students are graded on specific standards and can systematically improve their grade as they progress. The focus was less on a fixed mindset but more on a growth mindset as students improve as they continue to learn. Although this has benefits over a traditional grading program as students are given multiple chances to improve their grade and therefore should be more confident in taking risks, Kohn (2011) argued that this is merely a "rewarmed" version of the same old thing and does little to solve the negative influences from grading. In fact, the emphasis on grading over learning may become even more profound. When students are constantly working toward a point system of improvement, that becomes their focus. They work toward attainment of improved grades and can become obsessed with the process and fulfilling the requirements rather than participating and enjoying learning the material being taught (Kohn, 2011). This interferes with the process observed in flow theory in which a student becomes so involved in their own learning that there is no measure for it and they don't care if it is measured or not (Csikszentmihalyi, 1990).

Although not a new concept, a recent initiative has been the use of formative assessment for students to follow their own progression in knowledge, reflect on that progression, and make goals (Stiggens & Chappuis, 2005). Formative assessments are not intended to be part of the final grade for a student and are not reported in any formal medium in a course. If they are reported at all, they carry far less weight than the summative assessment. Formative assessments are intended to monitor accomplishments and challenges while providing feedback for the student and used as a tool for re-learning for the student and/or re-teaching for the teacher. The summative assessment is the score that indicates the final comprehension and knowledge acquisition of the student. However, not all researchers agree. In contrast, Marzano (2011) advocates for a program in which formative scores are recorded as a measure of progress and mastery is shown by summative scores. In both versions, however, this is an improvement over traditional grading as the student receives frequent feedback and can correct mistakes in a low risk environment before they truly become an issue or contribute to a misconception (Stiggens & Chappuis, 2005).

Motivation to Learn

Two theories have been identified as to why students are motivated to learn. One is the theory of mastery or goal orientation and one is the theory of performance orientation of which grades are a good example (Lai, 2011). In mastery or goal orientation a student sees challenges as an opportunity to master or improve their skills in a valued area while performance orientation is generally seen as competition with others in the acquisition of skills (Lai, 2011; Shumow, Schmidt, & Zaleski, 2013). Students with performance orientation see challenges more often as a threat. These goals can affect student motivation and hence their ability to learn effectively (Schweinle & Helming, 2011).

The issue of self-efficacy and tenacity, or the belief in one's own ability to learn and understand and the determination to overcome hurdles and difficulties in the process, is a critical issue. Students' beliefs about both their ability and the importance of the material greatly affect their tenacity in the learning process. The social situation and collective experience of the students, culture, and gender can impact the ability to persevere in the face of adversity and struggle (Duckworth, 2016; Dweck, Walton, & Cohen, 2014; Shaunessy-Dedrick, Suldo, Roth, & Fefer, 2015).

Boaler (2016) described a problematic situation in mathematics in which students have a "fixed mindset" rather than a "growth mindset". They believe they are either smart or they are not and can either do mathematical analysis or not and that this has been predetermined in their genetic make-up. This is also seen frequently in science (Dweck, Walton, & Cohen, 2014) where a subject which is based on logical reasoning and problem solving is taught as a series of rules and procedures and essential facts that must be learned and followed in order the get the "right" answer (Dweck et al., 2014). This "right" answer is identified on a test which is followed by a grade and which then sets up a competition culture among students. This does much to take the intrinsic motivation and joy out of learning, not to mention its cooperative nature. Instead it turns it into drudgery or something students must suffer through to get to the next stage of their education (Dweck et al., 2014).

Boaler (2016) argued for the development of a growth mindset and learning which is based on exploration, problem solving, and free thinking. In a study in mathematics education, three groups of students were assessed. One group was given traditional graded tests in mathematics. Another group was given only feedback and the third group was given both grades and feedback. Although it was expected that grading alone would be detrimental to learning, upon analysis the results indicated that grading in any form appeared to be detrimental to learning. The group that had only feedback scored the highest on the standardized test at the end of the program. The other two groups scored significantly lower. Boeler (2016) went on to describe situations in which a student's identity is so strongly tied to their grades that when they receive a poor grade they see it as their identity as a learner and not merely an opportunity to identify a misunderstanding that needs a little more work. Although Boaler (2016) strongly interprets these results, it is acknowledged that as grading and learning are a very complex process with a wide variety of variables, the cause of failure may not in fact be grading. However, the correlation is strong (Boaler, 2016).

Lin-Siegler, Ahn, Chen, Fang, and Luna-Lucero (2016) assessed students' belief in their ability to learn and do science. Although students could identify the traits inherent in a successful scientist such as the ability to find creative solutions to problems and hard work, they generally assumed that there was an innate ability or superior talent in scientists that was missing from other people. They believed that scientists were somehow innately smarter than others. In this study, the authors implemented a program in which students learned about the history of scientists and the struggles that they had in their lives before and while they were contributing to the science field. It was found that the stories about the scientists themselves appeared to make science more attainable and possible. This approach improved both academic success and student motivation (Lin –Siegler et al., 2016).

There has been much debate as to the variety and categorization of goals for which students are motivated. Seven goals have been proposed including: working to get the job done, earning a grade, enjoyment, mastery, interpersonal relationships, complying with directions, and avoiding trouble (Schweinle & Helming, 2011). Precise student goals are often debatable; however, the idea that goals influence motivation and success is widely accepted (Schweinle & Helming, 2011; Schutte, 2015; Shumow et al., 2013).

If students are to succeed in their educational goals, they must be motivated to do so, and they must believe that these goals are possible for them (Lin-Siegler et al., 2016). Therefore, it is important that teachers understand what student motivating factors are and understand how these vary for different students to provide the very best education for all with maximum rates of student success.

The Success of Computer Games in Learning and Brain Science

When observing students in a high school setting as they go about their day, it becomes obvious that they are increasingly attached to their electronic devices and they appear very motivated to engage with them (Eichenbaum, Bevelier, & Green, 2014). Much of this enchantment involves social media but a significant amount also involves game playing. Most interestingly, much of the gaming is also related to social media as students interact and compete electronically. There has been much criticism of this increase in entertainment technology as a waste of time and energy and an interruption of traditional education. However, this criticism does little to change the fact that an increasingly large proportion of student time and energy involves electronic media. Many techniques can be learned from the computer gaming industry that can be applied in a classroom setting either with a computer or without (Eichenbaum et al., 2014).

Technology is motivating students in ways that are far more powerful than the motivation they have for other aspects of their lives. Rather than criticizing the process, perhaps it is time to look at why technology has become so motivating for students. There is an element of computer gaming that encourages students to spend copious amounts of time (often 15 or more hours a week) on it and then strive for increasing success at skills related to it (Eichenbaum et al., 2014).

It has been demonstrated that video games encourage more time on task. In past studies in education, more time on task has been related to increases in learning (Eichenbaum et al., 2014). These games provide a variety of rewards for players in the form of bonus points, extra turns, and titles such as seen in the game called “Candy Crush” (Margalit, 2015). Whether on purpose or by accident, these games fulfill many psychological needs including autonomy, competence, and relatedness (Eichenbaum et al., 2014). These are the same needs that are repeatedly addressed by researchers when they discuss motivation and learning (Eichenbaum, et al., 2014; Froiland et al., 2012).

Research shows that when students play video games, they release a wide variety of neurotransmitters including dopamine. These are the same neurotransmitters that are implicated in addiction to a variety of both prescription and recreational drugs. This time, however, the addiction is not necessarily harmful but rather has the potential for improving cognition and learning (Eichenbaum, et al., 2014; Margalit, 2015).

Dopamine is a neurotransmitter associated with gratification and pleasure (Margalit, 2015). Recent research shows that dopamine has other functions as well. Dopamine appears to be a predictor of when a reward is expected (Hikosaka, 2010). Although the dopamine cells respond to a predicted pattern of reward they respond far more strongly to a surprise in predictability (Hikosaka, 2010). Evolutionarily, animals strive for predictability and understanding of patterns to anticipate both dangers and rewards in the struggle to survive (Margalit, 2015). Computer games such as “Candy Crush” play on this predictability by subtly changing the response that is needed as players increase in the complexity of the game. Games such as Candy Crush give the illusion of control. Human beings have a basic need to find order (Margalit, 2015). Lining up and finding patterns in sets of pictures fulfills this need even when it is only a game on a smart phone.

The timing of the reward has been seen to be critically involved in this process. Studies in reinforcement and rewards go as far back as the training and behaviorist philosophy as seen in Skinner’s operant conditioning work with rats in 1938 and Pavlov’s work with dogs in 1902. Educators and educational researchers have realized that reward is a very powerful extrinsic motivator (Margalit, 2015). However, the most motivating reward is not one that is predictable but rather one that is random. There is always the hope that a reward may come on the next try even if it was not received on this one (Margalit, 2015).

As mentioned by several researchers, to learn a student must feel free to fail (Boaler, 2016; Kohn, 2011; Eichenbaum et al., 2014; Margalit, 2015). It is through failing that animals learn the most. However, the failure must be on the edge of their ability to learn. If it is so far above their ability level that they consistently fail, they will quit all together. If it is too easy they quit from boredom. However, if the challenge is right at the edge of what the student can do, failure will be a challenge to try again (Froiland et al., 2012; Schweinle & Helming, 2011). Computer games repeatedly work within this psychological theory. Until a skill is accomplished, the player is not allowed to move to the next level. In fact, some games track the accomplishments of the players and then add additional skills strategically (Eichenbaum, et al., 2014).

According to Eichenbaum, et al. (2014), the most effective strategy of computer games is variability of learning. They are not based on the concept of remember and repeat. Rather, the skills and challenges are presented in a variety of ways and a variety of situations. To be successful in the game it is necessary to apply the skill at unpredictable times and in unpredictable situations. Eichenbaum et al. (2014), assessed the importance in variability in learning when the students or players were asked to predict the time that a bulb would light in a game. The test involved a series of several lights that lit up in a timed sequence. The player was asked to hit a button right before the last light was illuminated. One group had a series of lights that were always lit with the same sequence of timing. They became very good at hitting the button right before the last light was turned on. The other group had the same series of lights but had several different timing sequences as they practiced. The final test for both groups involved a sequence time that neither had experienced before. The group that had practiced with only one sequence did very poorly. The group that had practiced with a variety of different sequences did much better (Eichenbaum et al., 2014).

True learning can be best assessed by the ability to apply new learning and ideas and skills in novel situations to solve unanticipated problems and seek solutions. According to past studies, rote learning does not accomplish this (Eichenbaum, et al., 2014). Computer game producers, whether through design or by accident, have hit on this concept in learning and many of the games continually challenge player learning to be applied in myriad ways (Eichenbaum et al., 2014; Margalit, 2015). According to Eichenbaum et al. (2014) educators may have much to learn from the techniques of computer gaming as they explore student motivation and effective learning strategies.

A current movement termed “gamification” is exploring the possibility of tapping into the power of gaming as a path to learning (Knewton, 2017). This process uses the strategy and mental stimulation of games in the classroom to motivate students to learn. The elements used include “progression” as students see their success frequently and visually, “investment” such as awards and time challenges designed to make students feel pride in their work and “cascading information theory” in which students continuously unlock the next challenge or step in their progress. Games hold much potential for turning school into play with the resulting outcome of effective learning (Knewton, 2017).

Traditional Biology Curriculum

The traditional biology high school curriculum for the past decades usually involved a textbook in which students systematically covered material in sequential order. Although there is some variability in the sequence, most texts follow the normal sequence of biochemistry, followed by cell biology, followed by cell reproduction, genetics, and finally microbiology (Bowman & Govett, 2015). There may be some variability of when to teach ecology depending on the climate. There is argument that this sequence provides the basics from which children will build their future knowledge. In the recent past, biology education has been a course frequently based on memorization and classification in a survey format. Many argued that this curriculum was a mile wide and an inch deep. Students never had the opportunity to truly delve into any specific area of interest (Bowman & Govett, 2015).

Most notably lacking in the traditional curriculum is the focus on inquiry and critical analysis even though researchers have advocated for it since the 1980s (Bybee, 2006). Students are encouraged to think of the science of biology as a series of facts that must be learned and are without question (Bowman & Govott, 2015). This could not be further from the truth. As science progresses it becomes ever more obvious that before a textbook is in print, it is already out of date as scientific knowledge advances (Bowman & Govott, 2015).

Next Generation Science Standards

The Next Generation Science Standards (NGSS) are the newest guidelines for the study of science. They are a continuation of a work begun with the creation of the National Science Education Standards from the National Research Council (NRC, 1996) and the Benchmarks for Science Literacy from the American Association for the Advancement of Science (AAAS, 1991). These two guides were originally intended to guide the development of the individual state science standards (NGSS, 2013). These resources are now approximately 15 years old and with new research in both science and how students understand science it was time to take another look and develop a new source and view of the standards and learning science (NRC, 2012). The National Research Council (NRC), the National Science Teachers Association (NSTA), the American Association for the Advancement of Science (AAAS), and Achieve have collaborated with over 40 writers from 26 states to put together this comprehensive resource for science called the Next Generation Science Standards (NGSS, 2013). The new standards incorporate a three-dimensional approach in which learners consider disciplinary core ideas, cross cutting standards, and science and engineering practices as they weave together to allow students to truly understand and do the process called science.

As time has gone on, the traditional method of learning biology has been found to be dated. The topics that have been taught as facts have slowly been either disproved or changed either subtly or sometimes radically as science advanced and the importance of the skills needed to do science has increased (Bowman & Govett, 2015). For example, the study of molecular biology as a central dogma of DNA going to RNA going to protein has now been modified substantially. As scientists started to understand the implications of DNA structure, folding, regulation, and modification as the power of epigenetics, it became apparent that the expression of genes and the working of enzymes are far more complex than the central dogma implies. The Next Generation Science Standards emphasize models of what might be rather than teaching what is presumed to be truth (Bowman & Govett, 2015).

To date, at least 26 states have become partners in the adoption of these standards. This supports a growing focus on adopting standards that can grow and adapt to the skills that scientists need instead of simply supplying information as had been in the past through traditional textbook courses. An emphasis on inquiry and critical thinking is crucial and will not be successful if it does not start until college. The Next Generation Science standards focus on this type of thinking throughout the science education of the student (Bowman & Govett, 2015).

PLTW Learning Program

In 1997 a group of scientists and teachers developed a program in engineering called Project Lead the Way. In the past 10 years, this has grown to include biomedical science. The

Project Lead the Way (PLTW) series of courses was built on the idea that students need access to real world and applied learning experiences that help them gain the skills they need to thrive in college, careers, and life. The program focuses on students obtaining real life problem solving, collaboration, and communication skills (PLTW, 2017). In addition, it also encourages students to explore a wide variety of career paths. The teacher becomes the facilitator while direct instruction is minimized. The student takes control of their own learning (PLTW, 2017).

The PLTW programs have several pathways. Among them are Engineering, Computer Science, and Biomedical Science. The APB Approach (Activity, Project, and Problem Based) centers on skills, projects, and problems that can be applied to real life situations (PLTW, 2017). The goal of this learning is application in a variety of formats while fulfilling the human requirements of autonomy, competence, and relatedness (PLTW, 2017).

The biomedical science program is based on four sequential year-long classes (PLTW, 2017). These include Principles of Biomedical Science, Human Body Systems, Medical Interventions, and finally during the senior year, Biomedical Innovations. The first course, upon which this research was based, is called Principles of Biomedical Science. It involves the death of a fictional character. The students are asked to solve the death of Anna Garcia. Through the course of the year students explore the many symptoms and diagnoses that are presented via her health history reports and autopsy reports. To understand the situation and solve the many problems related to the death of this woman, the students must learn the concepts of biology and understand many of the biological processes involved. The concepts are applied in a relevant life drama while technology is used to enhance the learning via Vernier probe-ware and simulations involving everything from protein folding to heart electrical functioning. The activities involve model building of insulin receptors, new design proposals for arterial stents, and inquiry into the causes and effects of various stimuli on heart rate and blood pressure. On the last day of class, the students receive the final autopsy report and can determine whether their hypothesis, based on their accumulated data and knowledge, is consistent with the death of Anna. The intention of this course is not only to teach the basic features of biology but to draw students into continued study in science and a working knowledge of the skills needed and the careers that are available in the future (PLTW, 2017).

There are no textbooks, but students are virtually connected to an adaptable curriculum. The curriculum can be updated nationally at any time as it is a flexible living document rather than a published textbook. Individual teachers have the capability of modifying it as they see fit and in relation to student interest. In this way, the material and scientific information is up to date and relevant on a nearly immediate basis. Students repeatedly work to critique and judge internet sources as to their reliability as they research the cutting edge of medical science (PLTW, 2017).

Motivation to Learn Science

Some would argue that science is a unique case in education although in many ways, the needs of science are also those of many other fields of study. By its very nature and definition, it is learning to understand and observe the natural world and solve human problems as they occur related to these observations (NGSS, 2015). In many ways it is like the way humans learned as hunter-gatherers throughout history (Gray, 2008). In the past several years, the cognitive aspects of learning science have been analyzed extensively. With the advent of both national and state science standards, many resources have been put into effective science education. Science is “built upon a developmental progression of ideas and concepts with the principle that students learn best within a context and structure” (NRC, 2012, p. 117). In science, a student builds on core ideas that can be applied across multiple science disciplines as they connect ideas and experience their application in the real world (Moulding et al., 2015). The Next Generation Science Standards (2015) focus on the three dimensions of science learning that describe the idea that science learning is based on: 1) Science and Engineering Practices, 2) Disciplinary Core Ideas, and 3) Cross Cutting Conceptual Ideas (NGSS, 2015). In this way the science standards identify areas and connections between many disciplines. By cross cutting conceptual ideas, the concepts are more coherent and can become a part of a student’s scientific view of the world. The intent is to bring relevancy and reason to the study of science rather than studying separate concepts seemingly in a silo and apart from other related disciplines (NGSS, 2015).

In addition to connecting concepts, the Next Generation Science Standards (2015) also focus on making science relevant and interesting for extended and diversified groups of students. The standards are written so that disparities between groups relating to experiences and relatedness of science concepts are recognized. Traditionally those students with more encouragement and opportunity in science have had a distinct advantage and often more motivation and courage to become involved in science. The Next Generation Science Standards (2015) attempt to remedy some of these inequalities and make science truly accessible and motivating for all students.

Moulding et al. (2015) made the point that paramount to science is curiosity. This curiosity is innate in children. It is the emotion that moves them to explore their world and test their reasoning within it. It can best be described as an intrinsic motivational source and an emotion residing within the affective domain (Rivera, 2013). Although curiosity is not reason, it is the motivation by which human beings seek understanding (Moulding et al., 2015). Humans have always sought explanations for the natural phenomena they have observed (Moulding et al., 2015; Rivera, 2013). In science, curiosity is the emotion that allows for students to learn science well. It provides the wonder, the connection, and the depth through which learning lasts for a lifetime (Rivera, 2013).

According to Moulding et al. (2015), curiosity involves observation and wonder at the natural world which lead to questions. As the students seek answers to the questions they ask, they become interested and seek information and data to answer those questions. This leads to reasoning as they construct explanations based on the evidence they are observing and build their scaffold of knowledge to understand how the world works (Moulding et al., 2015). Through this natural process fueled by curiosity, learning becomes the development of problem solvers who look for causality verses explanation by magic or superstition. Thus, they are learning by doing science and creating sense to their own understanding of the natural world (Boaler, 2016; Moulding et al., 2015; Rivera, 2013). The motivation needed to pursue this process is important to true learning.

Chapter Three: Methodology

Philosophy and Justification

Students in ninth-grade face a plethora of challenges (DaGiau, 1997). This was the transition year from middle school to high school for the students in this study. They had gone from being "king of the hill" to the "bottom of the pack". They were often insecure, uncomfortable in their own bodies and trying hard to impress each other. They did not quite know what was required of them. They were often torn between advice and suggestions from others and their own personal interests (DaGiau, 1997).

Each year the four-year high school in this study had 300 to 400 new ninth-graders. Enrollment may have varied slightly throughout the year as individual student situations evolved. Although there were some choices in the curriculum, each student was required to take an English course, a math course, a social studies course, and a science course. Most students enrolled in one of three available biology courses during their ninth-grade year to fulfill one of their graduation requirements in science.

One choice was the standard ninth-grade biology course as identified in this school district as "Regular Biology". This course was taught in a classroom setting from a traditional biology text with chapters and units. The units consisted of: scientific methodology, ecology, cell biology, biochemistry, genetics, and microbiology. Depending on the time available, anatomy and physiology may have been introduced. The students who typically took this course often were not confident that they either liked or could do science well, so they shied away from honors level courses, which they believed would be more difficult. They often took the course to fulfill their curricular requirements in science for high school graduation and it is possible that they initially had a lower motivation to succeed in science than students who chose the other courses.

The second course choice was “Honors Biology”. Honors biology was like the regular biology course with a common text with chapters and similar units. The difference between honors biology and the regular biology course was that the material tended to be covered more deeply and more quickly. In addition, long term formal inquiry-based research projects in classical science fair format were included. If a student earned an A or a B in the class, they qualified for honors credit. Honors credit was desirable because it helped to qualify students for an honors diploma and was weighted in their Grade Point Average (GPA) in such a way that an A in the course was worth 5.0 points instead of 4.0 points. In these courses the grade earned was multiplied by 1.25. Students who took this course tended to have more confidence and efficacy in their ability in science and they were college bound more often, with many hoping to pursue science degrees.

The final course that was offered was in its fifth year of implementation and had been growing steadily in size. This course was called “Honors Biomedical Science”. It was a hybrid of the Project Lead the Way Principles of Biomedical Science (PLTW, 2016) and the honors biology course that had been taught at this school and previously described. PLTW is a nonprofit organization that was founded in 1997. The purpose of the organization was to provide STEM (Science, Technology, Engineering and Math) programming and curriculum for elementary, middle, and high schools. The program began with engineering and had most recently included biomedical science. The premise was to expose students to project based, current and relevant learning embedded within a network of community career opportunities

(PLTW, 2016). Unlike the regular and honors biology courses, this class did not have a textbook but rather used resources directly from the Project Lead the Way on-line curriculum and the internet. It was not specifically divided into traditional chapters and units. Unlike the formal PLTW Principles of Biomedical science course, all Minnesota Science Standards for the nature of science and engineering and for life science had been included and embedded within the story of Anna Garcia. Therefore, this course was a hybrid of the traditional honors biology course and the PLTW Principles of Biomedical Science course.

When the honors biomedical science class began on the first day of school, students discovered that a woman named Anna had just very dramatically died. The students were charged with identifying the cause of her death. They began with forensics (in which they also studied scientific methodology, engineering, and problem solving), they found she had maggots and they had to determine when she died based on the life cycle of the maggots (they studied ecology), they found she had diabetes (they learned cell biology and biochemistry), she had sickle cell anemia (they learned genetics), she had a bladder infection (they learned microbiology), and she had heart disease (they learned molecular biology, anatomy, and physiology). The basic standards for life science were tied to a real-life scenario which students found relevant to their own experiences. The course was heavily imbued with open-ended questions, inquiry-based laboratory investigations, technology, and real-world engineering problems using current resources. The teaching strategy promoted was one of facilitation rather than direct instruction (PLTW, 2016). At the end of the class, students earned honors credit if they maintained an A or B average based on projects and test scores, and, if they passed the PLTW End of Course assessment, they may have earned college credit at some colleges and universities depending on their program requirements. The students who took this class were from a wide range of traditional academic levels. Traditional honors students, frequently designated as “Gifted and Talented", as well as students who had not taken honors classes in the past but were interested in a hands-on, real life perspective in science, were together in the course. In some cases, students who had not been successful in traditionally taught science courses tried this course as an alternative approach in learning.

Success could be obtained in all three courses but the reason for success and the definition of the success may have varied considerably. For some students, they were successful if they simply passed the class. For others, success was measured by grades and honors credit, and for another group success was measured by interest and curiosity. In an ideal world all students would seek to learn science because they are interested in the subject and inspired to learn more. These are the students who most frequently wanted to pursue further knowledge and possible careers in science (Aydin, 2014; Froiland et al., 2012).

Research Method and Design

The method for this research was quantitative in nature. Student opinion surveys identifying motivational strategies were administered (see Appendix A). Demographic data on course choice, grade, gender, identified ethnicity, socioeconomic status, and Minnesota Comprehensive Assessment (MCA) scores were collected (see Appendix B). In September, students began high school and started their first high school science course which was with very few exceptions, biology. At the end of the year following their study in biology, students were asked to complete a survey using Qualtrics and originally created by Ayden, Yerdelen, Gurbuzuglo, Yalmanci, and Goksu, (2014) that explored motivation for learning biology. They were also asked to complete six short demographic questions including class choice, grade, gender, identified culture, socioeconomic status as indicated by qualification to receive free or reduced-price lunch, and score category (exceeds standards, meets standards, partially meets standards, and does not meet standards) earned on their most recent MCA exam in science taken at the end of April 2017. The survey was completed in their biology class after the MCA test had been taken and the scores had been reported to school staff. The students did not know their score but were given a test code number from 1 to 4 which indicated which category they fell into. Students received their formal scores from the school district later in the summer, so they could not be disclosed to them when the survey was given. This survey took between five and ten minutes of student class time to complete.

The motivational type scores for the current ninth-grade class were correlated with course and score category on the Minnesota Comprehensive Assessment. This data was further analyzed according to student demographics including gender, ethnicity, and poverty as evidenced by the qualification for free or reduced-price lunch, to see if there were any apparent correlations or commonalities exhibited by these designated groups of students.

During this study, biology teachers who were members of the Biology Professional Learning Community worked together to ensure that all teachers taught the same concepts in similar ways and in a similar time frame correlating with the course they taught. Although the researcher was one of the teachers on the team, many students rotated classes at the semester due to scheduling conflicts, so student assignment was random and variable.

Research Questions

The following research questions were addressed in this study:

RQ1: What if any correlation exists between the type of motivation reported by students and the type of biology instructional method (traditional high school biology, honors level traditional high school biology and high inquiry-based honors biomedical science) they have experienced in high school?

RQ2: What if any correlations exist between the type of motivation reported by students and gender after the high school biology course experience?

RQ3: What if any correlations exist between the type of motivation reported by students and identified ethnicity after the high school biology course experience?

RQ4: What if any correlation exists between the type of motivation reported by students and socioeconomic status as defined by the qualification for free or reduced-price lunch after the high school biology course experience?

RQ5: What if any correlation exists between the type of motivation reported by students and success in learning biology as measured by the Minnesota Comprehensive Assessment in Science?

Theoretical Framework

The following theories of teaching and learning offered an outline of understanding for the study of motivation. Self Determination Theory (Froiland et al., 2012) described the human need to develop competence. Self-Efficacy Theory (Bandura, 1977; Dweck et al., 2014) is the belief in one's own ability to learn and succeed. Flow Theory (Csikszentmihalyi, 1990) describes the importance of having the optimal level of challenge for effective learning. Motivational Theory (Aydin, 2015) outlines the different types of student motivation to learn which include intrinsic, extrinsic, and atrinsic motivation. Dewey's Constructivist Theory and

Vygotsky's Social Constructivist Theory describe the methodology used by students and educators in the process of learning and assimilating meaning (UCD, 2017).

Variables

The independent variable for this study was the type of biology course in which each student was enrolled. The dependent variable was the primary motivational style the student exhibited at the end of the course. A second independent variable was the MCA score earned by the student (exceeds standards, meets standards, partially meets standards, and does not meet standards) as reported by the Minnesota Department of Education following the administration of the test in late April with motivation type as the dependent variable. Correlations with gender, identified ethnicity, and socioeconomic status were also analyzed as independent variables measured by motivation type. Controlled variables included the school in which the children were enrolled, the approximate age of the students, and the year or grade in which the class was taken. Variables that were not controlled but are acknowledged as they may influence the results are the past social and educational experiences of the individual child.

Hypotheses

The following hypotheses were based on the questions for this study.

$H1_0$: There is no correlation between the type of motivation reported by students and the type of biology instructional method they have experienced in high school.

$H1_a$: There is a correlation between the type of motivation reported by students and the type of biology instructional method they have experienced in high school.

$H2_0$: There is no correlation between the type of motivation reported by the student and gender after the high school biology course experience.

$H2_a$: There is a correlation between the type of motivation reported by students and gender after the high school biology course experience.

$H3_0$: There is no correlation between the type of motivation reported by students and identified ethnicity after the high school biology course experience.

$H3_a$: There is a correlation between the type of motivation reported by students and identified ethnicity after the high school biology course experience.

$H4_0$: There is no correlation between the type of motivation reported by students and socioeconomic status as defined by the qualification for free or reduced-price lunch after the high school biology course experience.

$H4_a$: There is a correlation between the type of motivation reported by students and socioeconomic status as defined by the qualification for free or reduced-price lunch after the high school biology course experience.

$H5_0$: There is no correlation between the type of motivation reported by students and their success on the Minnesota Comprehensive Assessment in Science.

$H5_a$: There is a correlation between the type of motivation reported by students and their success on the Minnesota Comprehensive Assessment in Science.

Individual student motivation varies from student to student and from groups of students to groups of students. Awareness of these differences may allow teachers to modify curriculum and teaching style to make it more relevant and engaging for the student.

Sampling Design

During the 2016-17 school year there were four classes of regular biology with 118 students, two classes of honors biology with 54 students and six classes of biomedical science with 176 students. Each class ranged in size from 25 to 32 students. Students were between the ages of 14 and 15 years old at the start of the school year and were enrolled in the ninth-grade. They have come from a variety of educational backgrounds, but all have chosen to take biology at this high school to fulfill one of their state high school graduation requirements in science.

The sample for this study consisted of freshmen (ninth-grade students in the 2016-2017 school year) in a Midwestern suburban school district. The total population of the school was 1,441 as of September 2016. The ethnic breakdown of the school for the 2016-17 school year was 4.4% Hispanic/Latino, 0.6% American Indian/Alaskan Native, 10.6% Asian, 9.2% Black/African American, 0.1% Hawaiian/Pacific Islander, and 72.7% White. Students identified as belonging to two or more races or ethnicities totaled 2.5%. English Language Learners accounted for 6.4% of the population and students designated as special education accounted for 9.6% of the population. Students who qualified for free or reduced-price lunch represented 23.2% of the population, and students classified as homeless accounted for 1% of the population. Preliminary data for 2015 indicated that 16 months after graduation 85% of students had enrolled in an institution of higher learning. This contrasts with the school district enrollment of 75% over three total high schools and the state enrollment of 72% who enroll in an institution of higher learning (MDE, 2017).

A few older students who were taking biology for the first time to fulfill their Minnesota life science standards requirement were involved with a total of approximately 360 students included in the study. Although these students were invited to take the survey, their results were eliminated as they did not fit the sample definition of ninth-grade. Although this sample was one of convenience it allowed for the optimum cooperation of both students and teachers and controls for individual variables in curriculum and pedagogical approaches between high schools.

Parents and students were contacted in the spring of 2017. They were invited to participate in the study following Institutional Review Board (IRB) approval and permission from the school district. Letters were sent to parents and students via paper in their classroom and over the skyward learning management system. After permission was obtained from parents, and students agreed to participate, the survey was given during the regular biology course period and required no more than 5 to10 minutes to complete.

Setting

The setting for this study included four traditional high school science classrooms in which ninth-grade biology was taught. Each teacher (3 women and 1 man) had their own room and the rooms reflected the personalities of the teachers but were not significantly different from the others. Students were enrolled in regular biology, honors biology or honors biomedical science. Regular biology is the traditional unit by unit sequenced biology course. The honors biology course is also run in the traditional sequence; however, additional projects are included, and the pace is increased. Biomedical Science Honors is a Project Lead the Way (PLTW) course intertwined with the Minnesota state standards developed with the intention of increasing higher levels of relevancy, inquiry, and engineering. It is based on a problem-solving scenario and includes an increase in open ended hands on activity and investigation and an increase in technology including internet research and experimental analysis.

Instrumentation and Measures

The primary instrument for measuring motivation was a Likert scale survey created and tested for relevancy by Ayden et al. (2014). Permission to use this survey was obtained from the author by email prior to the survey administration (see Appendix D). This survey (see Appendix A) was administered using the vendor Qualtrics following consent from parents and agreement to participate from students via appropriate permission forms (see Appendix C). The survey consisted of 18 questions on motivation and six demographic questions given to students at the end of the year following their biology requirement for the class of 2020. This survey was done using either or both classroom laptop computers or student personal devices during the daily biology class, following the MCA test in science, and after MCA scores for the class were reported and available to teachers. Demographic questions were added to the survey including: the specific biology course in which students were enrolled, the student grade level, MCA score categories (exceeds standards, meets standards, partially meets standards, and does not meet standards) they had earned, gender, socioeconomic status as identified by availability of free or reduced-price lunches, and identified ethnicity (see Appendix B). The students were given individual slips of paper with their MCA scores listed based on a number system of 4 for exceeds standards to 1 for does not meet standards. The students did not know what the numbers meant when they entered them into the survey program. This helped to ensure that students reported their scores accurately and assured privacy of the scores since no student knew the interpretation of the number system. Students received their scores later in the summer at the discretion of the school district. The students were assured of anonymity and were asked for their cooperation and honesty with this task. The reported scores were aligned with the motivational data from the surveys to explore a correlation with successful learning.

Reliability in this setting was measured by the responses to questions that analyzed separate categories using a Cronbach's alpha test. For the data to be reliable, students must have demonstrated similar scores on these types of grouped questions. This was compared to similar tests of reliability done by Ayden et al. (2014).

Validity in this setting was assessed by comparing this data to the study by Ayden et al. (2014). Since this data concerned student opinion and emotional motivational response, the validity was dependent on student honesty in answering questions. This was like tests of validity by Ayden et al. (2014).

Field Test

A field test was done by the Advanced Placement (AP) Biology students enrolled during the 2016-17 school year. Forty-four AP students participated in this group in Grades 11 and 12. Although the average age of these students was slightly higher than the students intended for the study and had already demonstrated some motivation to continue to study biology by taking an elective course, they were a good assessment of the workability of the research tool. These students were not part of the study group. The field test was done prior to IRB approval to refine the technology implementation and wording of the survey questions.

Students tested the technology of the program and the feasibility and timing of the survey. The survey took from four to seven minutes to complete. The Qualtrics program worked well and the data was accurately collected by the investigator. Students made minor suggestions for changes in wording for some of the questions and suggested that grade level be added to the demographic questions so that only ninth grade students would be included in the final study. However, they felt it was important not to publicly identify the students who were in the classes as they may be embarrassed that they had either not taken or had not passed their biology course in ninth grade. This was a reasonable change to the protocol for this study and was accepted as it would not affect the data collection of any other variables.

Pilot Test

The pilot test was done with one class of Honors Biomedical Science at a similar high school nearby. There were 12 full classes of 25-32 students involved in the study itself. One similar class of 25-32 students at a neighboring high school was used for the pilot test to assess the reliability of the test instrument. This was done following Institutional Review Board (IRB) approval.

A Cronbach's alpha test (Wessa, 2017) was done to assess the reliability of individual categories involving six questions for intrinsic motivation, four questions for atrinsic motivation, four questions for extrinsic social motivation, and four questions for extrinsic career motivation. A Cronbach alpha value of 0.9058, which indicates excellent internal consistency for intrinsic motivation, was found in this group of students. Cronbach alphas of .0.6259 for atrinsic, 0.6637 for extrinsic social, and 0.8427 for extrinsic career were found for those categories. These results indicate medium reliability for atrinsic and extrinsic social motivation and good reliability for extrinsic career motivation. This is not surprising as the number of questions for atrinsic, extrinsic social, and extrinsic career motivation are fewer in number and therefore affect the value of Crombach's alpha making it harder to obtain high numbers (Tavakol & Dennick, 2011). MCA scores were not available for this group of students. Validity of this instrument was assessed through correlation with MCA standards scores and motivation type within the test population.

Incentive

The survey was described to the students as a way to improve the course in the future and share this information with other educators. Most students saw school improvement as an incentive to participate in the study. Students had the right to refuse to participate with no consequences. Although teachers sent out permission forms a week ahead of the scheduled survey, students and parents had a choice of whether to return the permission form or not and their compliance was not obvious to other students in the class.

Data Collection

The survey (see Appendix A) which was administered to students was retrieved from the work of Ayden et al. (2014). One question was deleted due to redundancy when the survey was translated to English. Demographic Questions (see Appendix B) during the survey included: grade, high school biology course choice, gender, ethnicity, and the ability to receive free or reduced-price lunch at school. Students were asked about their ability to receive free or reduced-price lunch at school to assess socioeconomic status. Students were asked to report their current Minnesota Comprehensive Assessment Score category based on whether they exceeded standards, met standards, partially met standards or did not meet standards. The teacher gave them a 1-4 number which represented their score with 4 being exceeds standards, 3 being meets standards, 2 being partially meets standards, and 1 being does not meet standards. If a student did not take the Minnesota Comprehensive Assessment due to absence, they still took the survey but were asked to indicate that they did not take the test.

The survey included questions answered on a six-point Likert scale from strongly disagree to strongly agree (see Appendix A). The scale was chosen to be a six-point scale to eliminate the choice of indecision.

Data Analysis

The analysis was based on the categories of intrinsic motivation (questions 1, 6, 7, 9, 10, 17), atrinsic motivation (questions 8, 12, 14, 16), extrinsic social motivation (questions 2, 4, 11, 15), and extrinsic career motivation (questions 3, 5, 13, 18). A mean score for each category was determined to ascertain the motivational style favored by the student. The mean was used since the number of questions varied slightly between groups (from 4-6 questions). Each question ranged from strongly disagree to strongly agree. There were six choices with strongly disagree having a numerical value of one and strongly agree having a numerical value of six.

The statistical analysis of this data was an ANOVA analysis to determine the relationship between the traditional honors biology, traditional regular biology, and high inquiry-based biomedical science instructional methodology as they relate to each of the following motivational measures:

1. Average Score for Intrinsic Motivation
2. Average Score for Extrinsic Motivation – Career
3. Average Score for Extrinsic Motivation – Social
4. Average Score for Atrinsic Motivation

The ANOVA test allows for multiple independent variables. In this situation the class choice (Honors traditional biology, regular traditional biology, and honors biomedical science) are the independent variables. The test was done four times, one time for each type of motivation.

A second ANOVA test was done to determine if there is a difference between the motivational type by score (independent variable) and the categorized scores on the MCA exam. There are four MCA categories including: exceeds standards, meets standards, partially meets standards, and does not meet standards. Each motivation type was tested individually.

A third ANOVA test was done to determine if there were significant differences between ethnic groups of students (Asian, Black, Hispanic, and White) and their motivational scores. Each motivation type was done individually.

Independent T tests were done to determine if there were significant differences between the males and the females in each group of motivation types. Independent T tests were also done to determine if there were differences between students qualifying for free or reduced-price lunch and those who did not qualify.

A value of less than or equal to .05 was reported as a statistically significant result (Laerd Statistics, 2017). In the case of a p-score of .05 or less, it was reasonable to reject the null hypothesis. Summaries of the statistical results can be seen in tables 1-4 following the report of the data.

Limitations and Delimitations

Students may have had different teachers during this time and many changed teachers at the semester end. Therefore, the exact relationship with the teacher may have varied from student to student. Due to the formal, written curriculum and teaching method, the class content was similar if not identical. However, every class construct and mix were slightly different depending on the student mix and the teacher. There may have been some uncontrolled variables in diversity, experience, and culture within the classroom. The time of day that the class took place may have played a role in motivation as perceived by the student. Although teachers tried to coordinate grading and curriculum, there may have been minor differences in grading, enthusiasm, gender, age, and teaching style of the teacher.

Depending on family circumstances and student willingness and motivation to participate, not all students returned permission forms. This may have affected the outcome of some of the analysis, particularly in the regular biology classes. Student experience and trust of the educational system may have played a role in their willingness to participate.

Student registration for courses was done by student choice. Therefore, students may have exhibited motivation for a learning style prior to registration. The motivation at the end of the course may therefore have been at least partially influenced by the motivation exhibited by the student prior to the course.

The survey was offered on two consecutive days (June 1, 2017 and June 2, 2017) to accommodate teacher schedules. These were the only days the survey was offered to insure that all students were having relatively the same curricular experience at the time and their report of motivation was not unduly influenced by the most current activity or topic.

Ethical Considerations

Not all students have had the same counseling and/or advice in course selection, so they may not be in the course that best suits their interests or background. Once a student is identified as being more applicable to a different style of learning, it may not have been ethical to keep them in the class in which they were currently enrolled. However, as this is controlled by the registrar and not by the researcher, there is frequently not an option to change the course choice after registration due to scheduling conflicts.

Student identifiers were eliminated as students were under the age of 18 as high school freshmen. Therefore, the data was aggregated by averages and groups without individual student identification. Groups consisted of gender, ethnicity identified by the student, the ability to receive free or reduced-price lunch at school, class choice, and MCA score category. There was very little variation in age as students were either 14 or 15 years old and were enrolled as 9^{th-} graders. Minnesota Comprehensive Exam scores were reported as “exceeds standards”, “meets standards”, “partially meets standards”, and “does not meet standards” to decrease individual identification and preserve anonymity. To further reduce identification of individual students, students only knew their score as a non-distinct number value. The students did not know the purpose of the numbers or how they related to their scores when they entered them into the survey.

Students are not required by law to take the MCA test when it is given. Some students opted out of the test. They were included in the study for analyses not involving MCA scores but reported that they chose to not participate in the Minnesota Comprehensive Assessment in Science on their survey.

Chapter Four: Results

Survey Population

The survey population included 251 of 327 potential candidates in ninth-grade biology during the student's first year in a traditional (9-12 grade) high school. Thirty-seven students were absent the day of the survey, 38 students did not return the parent permission form, and one student refused to take the survey by recording inconsistent answers where the student entered strongly agree for all statements either positive or negative. It was therefore assumed the student did not agree to take the survey and was grouped with those that did not return the permission form (See Figure 4.1). This data set gave a confidence level of 0.95 and a confidence interval of plus or minus 2.99 percent.

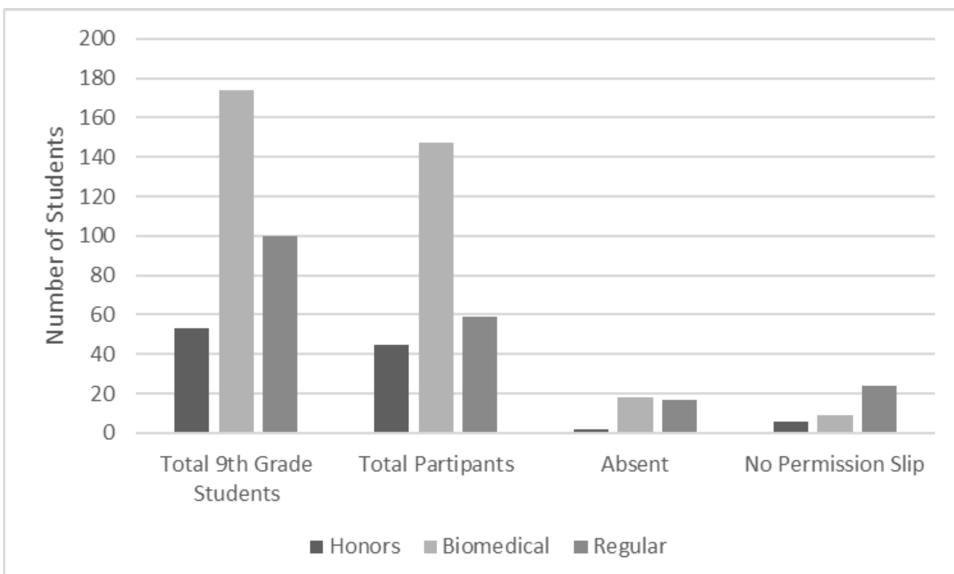

Figure 4.1. Survey population by class

Eighty-five percent of the ninth-grade students in two classes of honors biology participated in the study. Six students did not return the permission form and two students were absent the day of the study. Eighty-four percent of the ninth-grade students in the six classes of biomedical science participated in the study. Nine students did not return the permission form and 18 students were absent the day of the survey. Fifty-nine percent of the ninth-grade students in the four classes of regular biology participated in the study. Twenty-four students did not return the permission form and 17 students were absent during the day of the survey. Absences were like those seen in previous days with no obvious change in reports of illness during this time of the year (See Figure 4.1).

Findings for Research Question One

Research question one was "What if any correlation exists between the type of motivation style reported by students and the type of biology instructional method (traditional high school biology, honors level traditional high school biology or high inquiry-based honors biomedical science) they have experienced in high school?"

The hypotheses for research question one was:

$H1_0$: There is no correlation between the type of motivation reported by students and the type of biology instructional method they have experienced in high school.

$H1_a$: There is a correlation between the type of motivation reported by students and the type of biology instructional method they have experienced in high school.

The mean of scores for motivation types were computed as described in the methods section. Student scores were averaged for each category of motivation. A number value of one to six was given for choices of strongly disagrees (1) to strongly agrees (6). Student scores for motivation were averaged by course category and designated groups. Aggregate data was reported as the average of the student means for each category.

Intrinsic motivation was reported as strongest in the honors biology at an average score of 4.37, followed by the biomedical science students with an average score of 4.18, and then the regular biology students with an average score of 4.03 (see Figure 4.2). However, when an ANOVA statistical test was completed, this correlation was not significant and could be due to variation within the groups rather than between the groups (see Table 4.1).

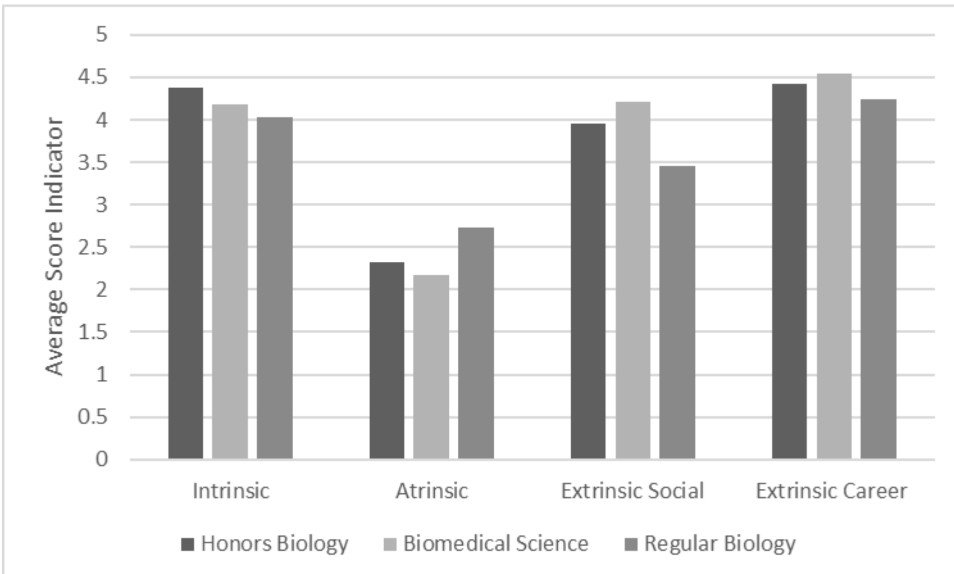

Figure 4.2. Whole class motivation averages

Atrinsic motivation was highest for the regular biology students at a score of 2.73, the honors students were in the middle with an average score of 2.32, and the biomedical science students were lowest with an average score of 2.17 (see Figure 4.2). According to an ANOVA statistical test, this result had a probability of 0.006, which was considered statistically significant (see Table 4.1).

Extrinsic social motivation was highest with an average score of 4.21 in the biomedical science class, the honors biology students had an average score of 3.96, and the regular biology class had an average score of 3.45 (see Figure 4.2). This result was significant by ANOVA with a probability of less than 0.001 (see Table 4.1).

Extrinsic career motivation was highest in the biomedical students with an average score of 4.54, the honors students had an average score of 4.42 followed by the regular biology students with an average score of 4.24 (see Figure 4.2). These results were not significant by ANOVA and any perceived correlation may have been the result of variation within the groups rather than between them (see Table 4.1).

Table 4.1

Statistical Summary for Research Question One

Class	Intrinsic Motivation	Atrinsic Motivation	Extrinsic Social Motivation	Extrinsic Career Motivation
Honors Biology	4.37	2.32	3.96	4.42
Honors Biomedical Science	4.18	2.17	4.21	4.54
Regular Biology	4.03	2.73	3.45	4.24
Significance by ANOVA	Not Significant	Significant p=0.006	Significant p=0.001	Not Significant

Since both atrinsic motivation and extrinsic social motivation showed statistically significant correlations, the null hypothesis has been rejected for research question one. The alternative hypothesis that there is a correlation between the type of motivation reported by students and the type of biology curriculum they have experienced in high school was accepted.

Findings for Research Question Two

Research question two was "What if any correlations exist between the type of motivation reported by students and gender after the high school biology course experience?"

The hypothesis for research question two follows:

$H2_0$: There is no correlation between the type of motivation reported by students and gender after the high school biology course experience.

$H2_a$: There is a correlation between the type of motivation reported by students and gender after the high school biology course experience.

The mean of scores for motivation types were computed as described in the methods section. A number value of one to six was given for choices of strongly disagrees (1) to strongly agrees (6). Student scores for motivation were averaged by course category and designated groups. Aggregate data was reported as the average of the student means for each category.

Student motivation was analyzed within each course by gender (see Figure 4.3). When the data was aggregated in this way, it became obvious that there were differences between the responses from the females as compared to the responses from the males within the classes. Statistical t-tests were done to compare the motivational types individually with the gender of the students in the class.

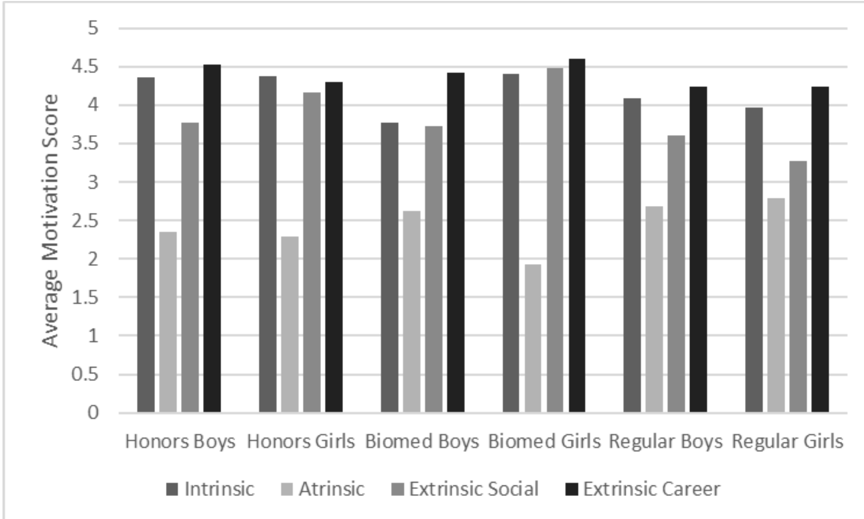

Figure 4.3. Students by class and gender verses motivation type

The honors biology students and the regular biology students did not show significant correlation between the reported motivational types and gender. However, the biomedical science students did show significant correlation in the areas of intrinsic motivation, atrinsic motivation, and extrinsic social motivation with the males scoring significantly differently than the females (see Table 4.2). For intrinsic motivation, the average score reported by females was 4.40 and average scores reported by the males were 3.77. This was significant by an independent t-test with a p-value of 0.001. For atrinsic motivation, the average score reported by the males was 2.62 and average score reported by the females was 1.94. This result was significant by an independent t-test with a p-value of less than 0.001. For extrinsic social motivation, the average score reported by the females was 4.48 and the males reported an average score of 3.72. This result was significant by an independent t-test with a p-value of 0.002 (see Figure 4.3 and Table 4.2).

Table 4.2

Statistical Summary of Results – Males/Females in Biomedical Science

	Intrinsic Motivation Average Score	Atrinsic Motivation Average Score	Extrinsic Social Motivation Average Score	Extrinsic Career Motivation Average Score
Boys in Biomedical Science	3.77	2.62	4.48	4.43
Girls in Biomedical Science	4.40	1.94	3.72	4.60
Significance by T-test	Significant p=0.001	Significant p=0.001	Significant p=0.002	Not Significant

The data supports the hypothesis that there is a correlation between gender and the type of motivation reported by students after their high school course in biology. Although this was not true for the honors biology and regular biology students, it was true for the group of students in the biomedical science class. There were significant correlations between gender in the biomedical science course and intrinsic motivation, atrinsic motivation, and extrinsic social motivation. There was not a correlation between extrinsic career motivation and gender in the biomedical science. There were not significant correlations with motivation type and gender in either the honors biology course or the regular biology course.

Although there were significant correlations between atrinsic motivation and social extrinsic motivation when the entire class was considered (see research question number 1) when the females and males were considered separately, there were also strongly significant correlations between gender in the biomedical science course and intrinsic motivation. The hypothesis that there are correlations between motivation type and gender was accepted. The null hypothesis was rejected.

Findings for Research Question Three

Research question three was "What if any correlations exist between the type of motivation reported by students and identified ethnicity after the high school biology course experience?"

The hypotheses for research question three were:

$H3_0$: There is no correlation between the type of motivation reported by students and identified ethnicity after the high school biology course experience.

$H3_a$: There is a correlation between the type of motivation reported by students and identified ethnicity after the high school biology course experience.

Reported ethnic groups in this survey included students who identify themselves as Asian, Black, Hispanic, and White. Although other categories existed (Native Hawaiian, Native American, and Pacific Islander) there were not enough students in those categories to carry statistical weight (only one or two students). Significant differences in motivation were found in atrinsic motivation with the highest score of 2.69 in the Black population and the lowest score in the Asian population at 2.13 (see Figure 4.5). This result was significant by ANOVA with a p-value of 0.046. Extrinsic career motivation showed significant differences according to ANOVA with a p-value of 0.029. In this category the highest average score was in the Asian population at 4.72 and the lowest average score was in the Hispanic population at 4.31 (see Figure 4.4). There was no significant difference in either intrinsic or extrinsic social motivation. (See Table 4.2)

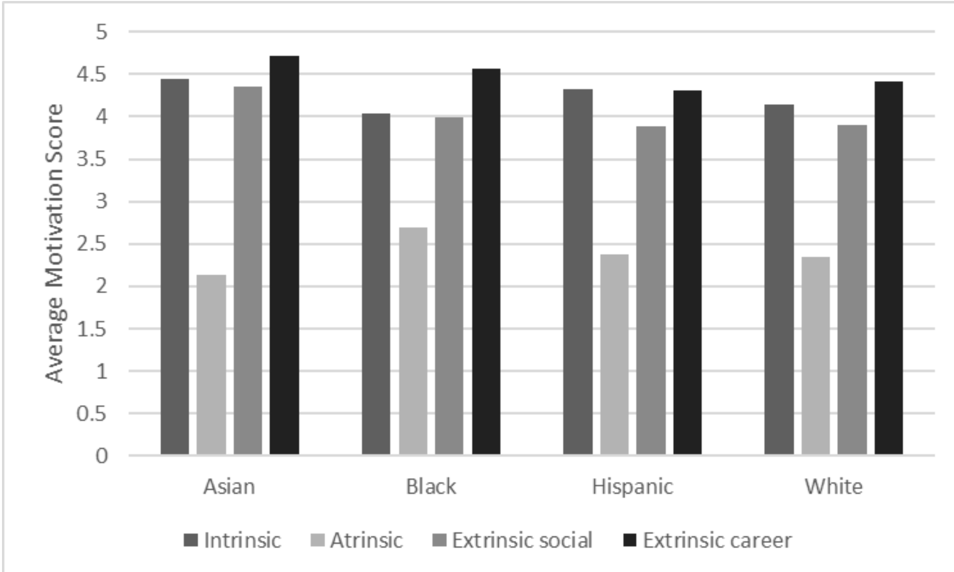

Figure 4.4. Motivation by ethnicity

Table 4.3

Statistical Summary of Motivation by Ethnicity

	Intrinsic Motivation	Atrinsic Motivation	Extrinsic Social Motivation	Extrinsic Career Motivation
Asian	4.44	2.13	4.35	4.72
Black	4.03	2.69	3.99	4.56
Hispanic	4.32	2.37	3.88	4.31
White	4.14	2.34	3.90	4.42
Statistical Significance by ANOVA	Not Significant	Significant p=0.046	Not Significant	Significant p=0.029

The motivation by ethnicity of males only or females only was not significant at any level related to motivation (see Figure 4.6). Although minor differences existed, the variability between each group showed no clear significance in areas of student motivation (see Figures 4.5 and 4.6).

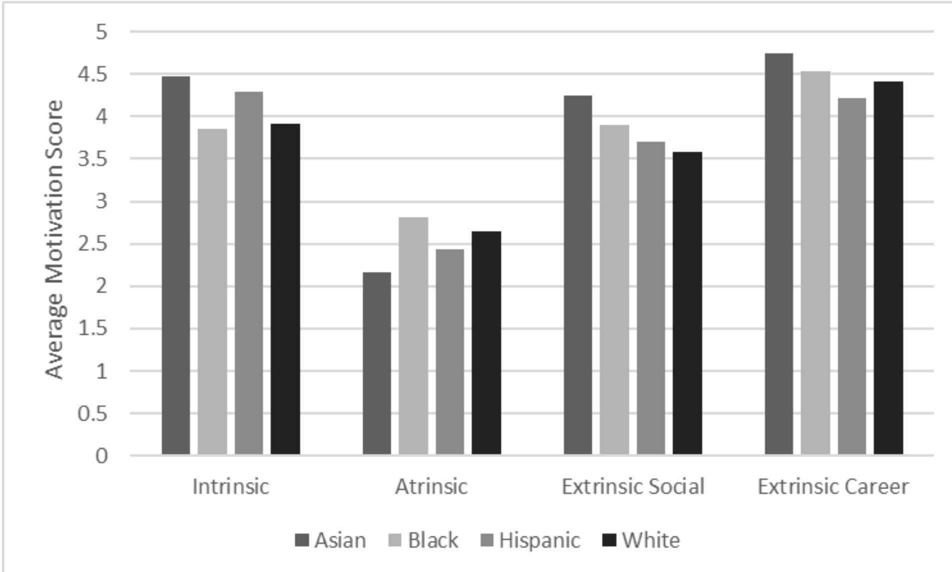

Figure 4.5. Motivation average scores by ethnicity – males

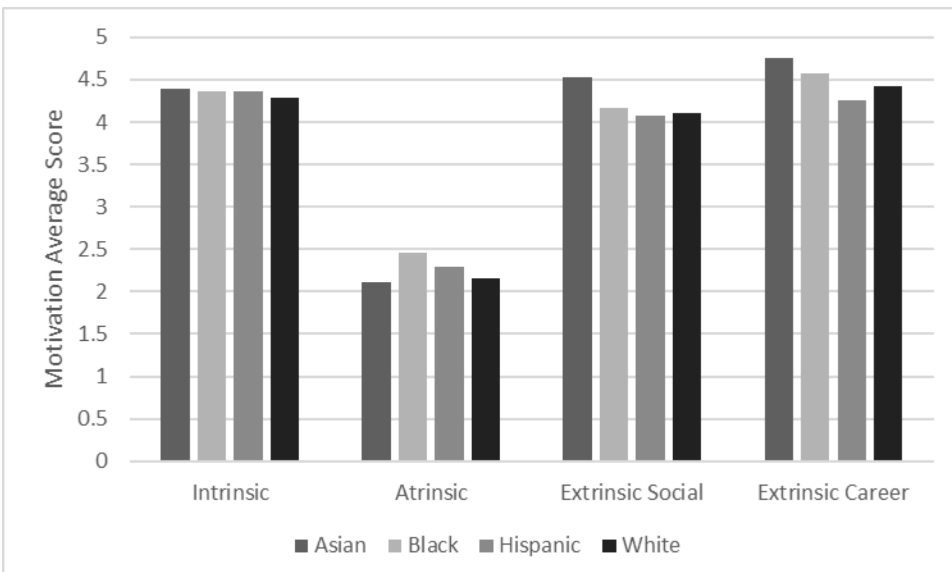

Figure 4.6. Motivation average scores by ethnicity – females

The proportion of students by ethnicity in this school, at the beginning of the 2016-17 school year (Minnesota Department of Education, 2016), was 11% Asian, 9% Black, 4% Hispanic, 73% White, and 3% "Other". The students in the ninth-grade for the honors biology course during the 2016-17 school year reported 21% Asian, 5% Black, 2% Hispanic, 71% White, and 1% chose the “Other” category. For the honors biomedical science course, students reported 14% Asian, 7% Black, 6% Hispanic, 68% White, and 5% chose the “Other’ category. For the regular biology course, students reported 18% Asian, 9% Black, 4% Hispanic, 62% White, and 7% reported their category as “Other”. Although there is some disparity between the courses, the breakdown is not different from the overall school cultural diversity (see Figure 4.7).

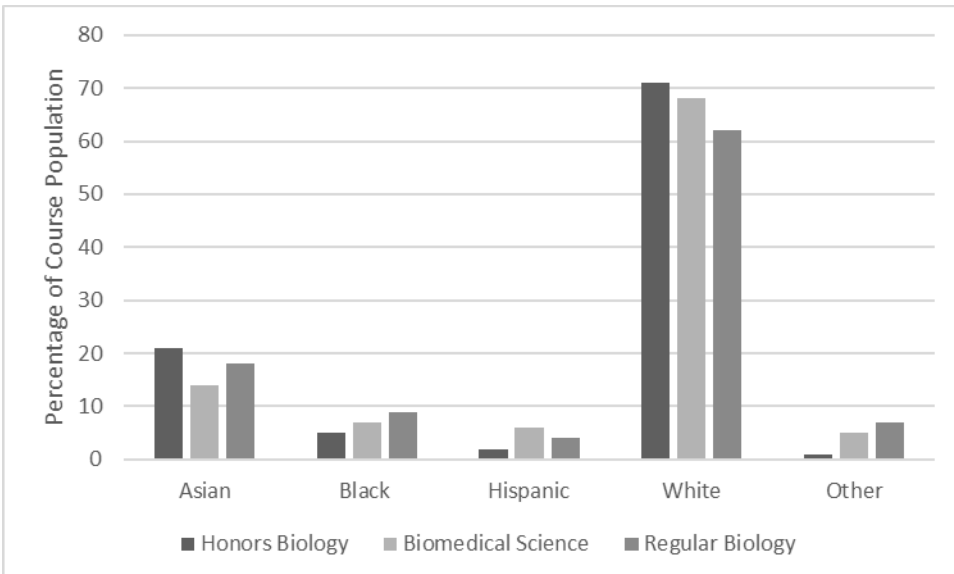

Figure 4.7. Ethnic percentage in each course

Significant differences in both atrinsic motivation and extrinsic career motivation were found in the categories of ethnicity. The alternative hypothesis that there would be correlations between motivation type and ethnicity was accepted. The null hypothesis was rejected.

Findings for Research Question Four

Research question four was “What if any correlation exists between the type of motivation reported by students and socioeconomic status as defined by the qualification for free or reduced-price lunch after the high school biology course experience?”

The hypotheses for research question four were:

$H4_0$: There is no correlation between the type of motivation reported by students and socioeconomic status as defined by the qualification for free or reduced-price lunch after the high school biology course experience.

$H4_a$: There is a correlation between the type of motivation reported by students and socioeconomic status as defined by the qualification for free or reduced-price lunch after the high school biology course experience.

There were no significant differences in any category of motivation between students who qualify for free or reduced-price lunch and those that do not (see Figure 4.8). The population of free or reduced-price lunch is higher in the biomedical science classes and regular biology classes. Only two students qualified for free or reduced-priced lunch in the honors class (4% of honors students), sixteen students in the biomedical class (9% of biomedical students), and 20 students in the regular biology class (20% of regular students).

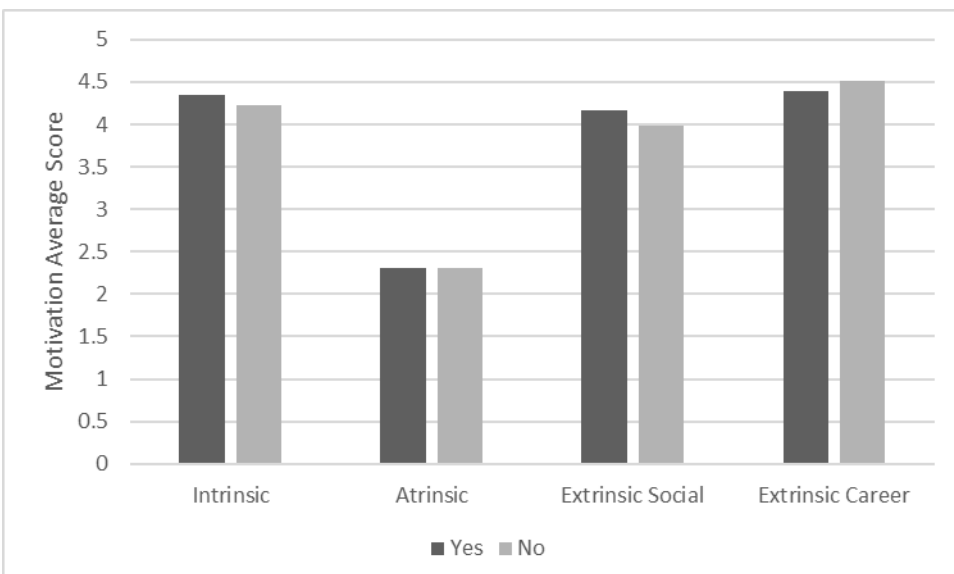

Figure 4.8. Free or reduced-price lunch students and motivation

In the category of socioeconomic status as depicted by student qualification for free or reduced-priced lunch there were no statistically significant correlations in motivation. Therefore, the null hypothesis for research question four was accepted. The alternative hypothesis for research question four was rejected.

Findings for Research Question Five

Research question five was “What if any correlation exists between primary motivation type reported by students and success in learning biology as measured by the Minnesota Comprehensive Assessment?”

The hypotheses for research question five are the following:

$H5_0$: There is no correlation between the type of motivation reported by the students and their success on the Minnesota Comprehensive Assessment in Science.

$H5_a$: There is a correlation between the type of motivation reported by students and their success on the Minnesota Comprehensive Assessment in Science.

The mean of scores for motivation types were computed as described in the methods section. Student scores were averaged for each category of motivation. A number value of one to six was given for choices of strongly disagrees (1) to strongly agrees (6). MCA scores were computed as “does not meet standards”, “partially meets standards”, “meets standards” or “exceeds standards”. Student scores for motivation were averaged by course category and designated groups. Aggregate data was reported as the average of the student means for each category.

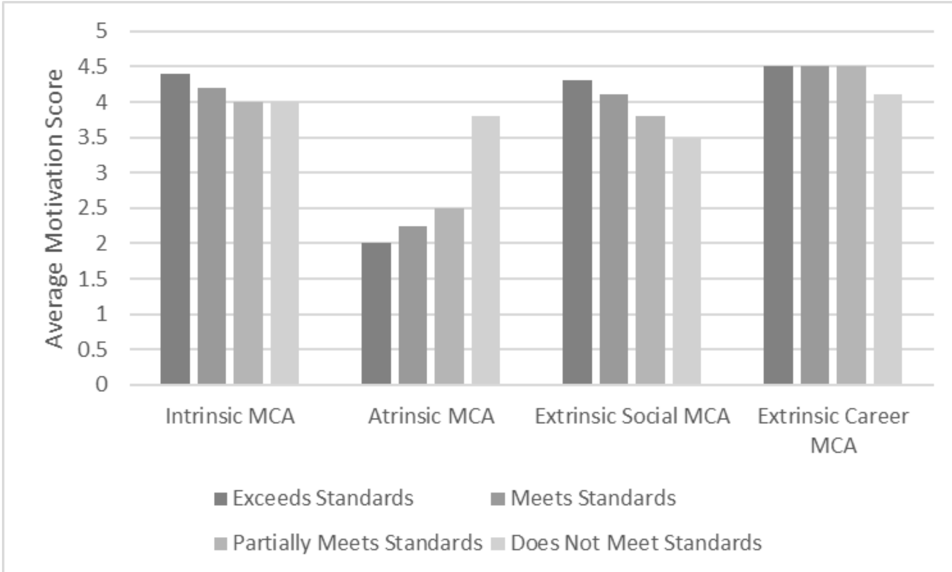

Figure 4.9. MCA average scores verses motivation type

Correlation of Minnesota Comprehensive Score (MCA) with Motivation

In reviewing the data, intrinsic motivation appears to drop consistently with MCA results although this finding it is not significant with a p-value of 0.059 by ANOVA. However, in an ANOVA analysis the results for atrinsic motivation show a strong negative correlation with a p-value of less than 0.001. Extrinsic social motivation positively correlates significantly with the MCA scores with a p-value of 0.003. Extrinsic career motivation did not significantly correlate with MCA scores (see Figure 4.9 and Table 4.4).

Table 4.4

MCA score correlation with Motivation Type

	Intrinsic Motivation	Atrinsic Motivation	Extrinsic Social Motivation	Extrinsic Career Motivation
Significance by ANOVA	Not Significant	Significant $p = 0.001$	Significant $p = 0.003$	Not Significant

The hypothesis for research question number five that there is a correlation between the type of motivation reported by students and their success on the Minnesota Comprehensive Assessment in Science was accepted. Atrinsic motivation and extrinsic social motivation correlate significantly with success on the MCA. Intrinsic motivation values did not show statistical significance. There is no significant difference between extrinsic career motivation and success on the MCA. The null hypothesis for research question five was rejected.

Additional Observations

Findings that were not part of the research questions for this investigation but may have implications for further research were noted. MCA scores were correlated with motivation type but could also be compared by class, ethnicity, and students who qualified for free or reduced-priced lunch. In order to obtain an average, the categories were given a number from one to four with one indicating a student does not meet the standards and four indicating the student exceeds standards. In the case of class choice, the highest MCA scores as indicated by more students achieving scores which designate them as at least partially meeting the standards were seen in the honors biology (2.22) and honors biomedical science (1.91) students. The average regular biology students (0.96) did not meet the standards.

When MCA scores were considered in the same manner but within the realm of ethnicity, significant differences were found only when gender was considered alone. An ANOVA test revealed that there was significant correlation between groups of female students with a p-value of 0.039. The Black females had the lowest average scores of 0.83 which indicates the students "did not meet standards", while the average white females averaged 1.88 which "partially met the standards".

The students who qualified for free or reduced-priced lunch had a significantly lower average MCA score than students who did not qualify for free or reduced-price lunch. Students who qualified had an average score of 1.29 which “does not meet standards” while students who did not qualify had an average score 1.92 which “partially meets standards”.

Although this data is preliminary and only categories of scores were available rather than actual scores, they may indicate that further research needs to be done in these areas.

Chapter Five: Discussion, Implications, Recommendations

Overview of the Study

Student motivation has been linked with student success in past studies as authors have correlated the motivation of students with science educational success as measured by both tests and future involvement in science (Duckworth, 2016; Dweck et al., 2014; Schweinle & Helming, 2011).

The current study explored the types of motivation and relative levels of motivation reported in a survey of students in ninth-grade biology classes. Twelve different classes in three different courses which used different instructional methods were included in the study. At the end of the course, ninth-grade students took an 18-question survey on how they felt regarding the study of biology. The survey was modified from a survey designed for this purpose by Ayden et al. (2014). Students were also asked to indicate six demographic characteristics including year in school, gender, course chosen, identified ethnicity, score category on their recent Minnesota Comprehensive Assessment, and whether they were eligible for free or reduced-price lunch as an indication of poverty.

The data collected from the survey was analyzed to determine a relative reported level of motivation for intrinsic motivation, atrinsic or lack of motivation, extrinsic social motivation, and extrinsic career motivation for learning biology. Motivation was correlated with Minnesota Comprehensive Assessment (MCA) scores to determine if the motivation type indicated correlated with success in learning biology.

Statistical analyses in the form of t-tests and ANOVA tests were done to assess any relationships between motivational type, success on the MCA tests, gender of the student, ethnicity of the student, and qualification for free or reduced-price lunch as an indicator of poverty.

Purpose of the Study

Based on the identified problem, the purpose of this study was to find correlations between instruction methodology as exemplified by the biology course and types of motivation reported by students. An additional problem was the question of whether these types of motivation were influenced by gender and/or identified ethnicity and/or qualification for free or reduced-price lunch. Whether any correlation existed between motivational type and success as defined by the Minnesota Comprehensive Assessment in Science was also considered. Once successful motivational factors were identified, instructional methodology and strategies may be targeted that help to make learning relevant for each child so that they can achieve at their greatest potential.

Research Questions

Five research questions were examined in this study.

RQ1: What if any correlation exists between the type of motivation style reported by students and the type of biology instructional method (traditional high school biology, honors level traditional high school biology and high inquiry-based honors biomedical science) they have experienced in high school?

RQ2: What if any correlations exist between the type of motivation reported by students and gender after the high school biology course experience?

RQ3: What if any correlations exist between the type of motivation reported by students and identified ethnicity after the high school biology course experience?

RQ4: What if any correlation exists between the type of motivation reported by students and socioeconomic status as defined by the qualification for free or reduced-price lunch after the high school biology course experience?

RQ5: What if any correlation exists between the type of motivation reported by students and success in learning biology as measured by the Minnesota Comprehensive Assessment in Science?

Research Population Participation

Seventy-seven percent (251/327) of the current ninth-grade students at the Midwestern high school in this study participated. There was some disparity as to which students were most likely to participate. The honors biology students had 84.9% (45/53) participation, the honors biomedical science student participation was 84.4% (147/174), and the regular biology class participation was 59% (59/100). The discrepancy in numbers may represent many variables. Absences on the day of the survey were higher in the regular biology class but this was consistent with absences that occurred routinely in that class and was not thought to be a result of the expectation of taking the survey. Failure to return parent permission forms was also lower with the regular biology class. This may reflect several factors including investment in the importance of the survey and personal experience with the researcher as many students did not have the researcher as one of their teachers. It is also possible that these students simply did not wish to participate in the survey. For many low performing students, trust in the educational system and the teachers involved has been found to be lower than other students (Evans, 2012). This may be a contributing factor in the lower numbers of participating students in the regular biology course.

Conclusions

Research Question One Findings and Recommendations

Research question one was "What if any correlation exists between the type of motivation style reported by students and the type of biology instructional method (traditional high school biology, honors level traditional high school biology, and high inquiry-based honors biomedical science) they have experienced in high school?"

The null hypothesis and alternative hypothesis for research question one were:

$H1_0$: There is no correlation between the type of motivation reported by students with the type of biology instructional method they have experienced in high school.

$H1_a$: There is a correlation between the type of motivation reported by students and the type of biology instructional method they have experienced in high school.

The results indicate that there were some differences between the types of motivation reported and the type of biology instructional method experienced. Intrinsic motivation appears highest in the honors biology class followed by the biomedical science class and finally by the regular biology class. However, this result did not indicate a significant difference using an ANOVA statistical test. This suggests that while there was variability in the amount of intrinsic motivation displayed in each of the courses, those differences were not significantly different.

However, levels of atrinsic motivation were significantly different between the courses. The regular biology course students exhibited the highest levels of atrinsic motivation. They were not particularly interested in learning biology. Considering that this was the only class that was not an honors credit course and that students chose this course expressly knowing that it was not an honors course, it may be that students who were not particularly interested in biology signed up for this course to fulfill the biology component of their graduation requirements. They may have begun the course already having high levels of atrinsic motivation. The second highest level of atrinsic motivation was found in the honors biology course and the lowest level of atrinsic motivation was found in the biomedical science course (See Figure 4.2). Both courses are honors level courses, but the biomedical science course was expressly designed to have strong relevancy with real life scenarios and a high inquiry component. Past research has indicated that this type of learning frequently engages students at higher levels and therefore influences their motivation as well as their lack of motivation (Hunter, 2014; Planchard et al., 2015; Robinson & Oaks, 2008).

Extrinsic social motivation is described as motivation that comes from the social benefit derived from learning. Students are motivated to learn so that they can impress their parents, their teachers or their friends. In high school where peer relationships are strong and influential, this type of motivation is frequently high. It can be a positive force in student achievement as well as a negative force when it may result in high stress and anxiety (Lyman & Luther, 2014). It can also be a motive that does not correlate with academic success when it is aligned to poor performance. In some cases, this can occur when students find social value in not doing well in school or when they want to fit in and not stand out as different from their friends (Gianacola, 2000). In the current study the biomedical science students showed the highest levels of extrinsic social motivation, followed by the honors, and then the regular biology students. This was a statistically significant result with a probability of 0.001 using an ANOVA test. The students in these courses often worked in groups and collaborated on a regular basis. For example, a valuable member of the team may have been highly respected and therefore, the social extrinsic reward system was reinforced as their needs for self-esteem and social recognition were met (Maslow, 1954). This was a purposeful component of the biomedical science course and may have contributed to the higher level of extrinsic social motivation.

It is also possible that students in the group preselected this course based on their high level of social extrinsic motivation. In the town in which this high school is located, there is a large and prestigious medical institution. It may be that students perceive the medical profession as being particularly attractive or at least familiar to them.

Extrinsic career motivation or motivation related to success or acceptance into a future career track was high in all courses compared to other types of motivation with average scores of 4.54 for the biomedical group, 4.42 for the honors group and 4.24 for the regular group. The ANOVA statistical analysis of these results indicates that there is no significant difference between the levels of extrinsic career motivation for these three groups of students. All students appear to value and recognize the importance of learning to succeed in careers. Even students who did not choose an honors option indicated an appreciation for the value of the subject as it related to future jobs and careers.

The hypothesis for research question one states that there would be differences between student motivation exhibited in the survey and the biology instructional methodology of the course in which the student is enrolled. Students showed significant differences in both atrinsic motivation and extrinsic social motivation. The level of intrinsic motivation and extrinsic career motivation showed no significant correlation with course type. The data supports the alternative hypothesis. There are significant differences in extrinsic social motivation and atrinsic motivation in students enrolled in different courses. Therefore, the null hypothesis was rejected, and the alternative hypothesis was accepted.

Research Question Two Findings and Recommendations

Research question two was "What if any correlations exist between motivation styles reported by students and gender after the high school biology course experience?"

The null hypothesis and alternative hypothesis for research questions two were:

$H2_0$: There is no correlation between the type of motivation reported by students and gender after the high school biology course experience.

$H2_a$: There is a correlation between the type of motivation reported by students and gender after the high school biology course experience.

The most obvious differences occurred in the category of gender within the honors biomedical science class. When the scores for the males and females were separated from each other, some significant differences were found. There were no significant differences between the females and the males in either the honors biology classes or the regular biology classes. However, the biomedical science students had significant differences in the case of intrinsic motivation, atrinsic motivation, and extrinsic social motivation. In fact, the females in this category scored higher than any other group of students in intrinsic motivation. In addition, the females in biomedical science also scored lowest in atrinsic motivation and highest in extrinsic social motivation than any other group.

The reasons for this are complex and not completely understood. It has been reported that young women are greatly influenced by subjects and topics that are people-oriented and are socially relevant (Gurian & Stevens, 2004; Koul et al., 2012). They are also strongly influenced by role models and stereotypes (Cheryan, 2017). It is also probable that the teaching strategy, which is one of facilitation rather than direct instruction, is more conducive to the socially involved mind of young women at this stage of development (Gurian & Stevens, 2004). In comparison, the young men in this group were significantly lower than the young women in intrinsic and extrinsic social motivation and were higher in atrinsic motivation. In intrinsic motivation, they were also slightly lower than the males in other groups. Whether this is due to the course or these students had lower intrinsic motivation to begin with is unknown. Further study is needed in this area.

As there were significant correlations between motivation style and gender in intrinsic motivation, atrinsic motivation, and extrinsic social motivation, the alternative hypothesis was accepted. The null hypothesis has been rejected for research question two.

Research Question Three Findings and Recommendations

Research question three was "What if any correlations exist between the type of motivation reported by students and identified ethnicity after the high school biology course experience?"

The null hypothesis and alternative hypothesis for research question three were:

$H3_0$: There is no correlation between the type of motivation reported by students and identified ethnicity after the high school biology course experience.

$H3_a$: There is a correlation between the type of motivation reported by students and identified ethnicity after the high school biology course experience.

In the case of identified ethnicity, results of the survey show some significant differences in the four groups that were prevalent in the survey (Asian, Black, Hispanic, and White) as a whole. Significant differences in motivation were found in the categories of atrinsic motivation and extrinsic career motivation. The highest score in atrinsic motivation was reported by the Black student group while the lowest score was reported by the Asian student group. In extrinsic career motivation, the highest scores were reported by the Asian students while the lowest scores were reported by the Hispanic students.

Past research on culture and ethnicity suggests that Asian students are frequently strongly motivated in science (Levinsohn, 2007). Unfortunately, it is also true that past research reports that African American or Black students are not as strongly motivated (Hurley et al., 2009). This may be due to differences in values and norms and may not reflect motivation to learn as much as learning style and cultural values. The Asian culture has been observed to strongly value competition, attentiveness, and hard work (Levinsohn, 2007) while the African cultures are frequently more community oriented and prefer to work as a group rather than independently (Hurley et al., 2005). Although the biomedical science class had more group work, there were not enough Black students in that course to see statistical differences. Further study may be needed in this area.

As there were significant correlations between motivation style and ethnicity in both atrinsic motivation and extrinsic career motivation, the alternative hypothesis was accepted. The null hypothesis has been rejected for research question three.

Research Question Four Findings and Recommendations

Research question five was "What if any correlation exists between the type of motivation reported by students and socioeconomic status as defined by the qualification for free or reduced-price lunch after the high school biology course experience?"

The null hypothesis and alternative hypothesis for research question three were:

$H4_0$: There is no correlation between the type of motivation reported by students and socioeconomic status as defined by the qualification for free or reduced-price lunch after the high school biology course experience.

$H4_a$: There is a correlation between the type of motivation reported by students and socioeconomic status as defined by the qualification for free or reduced-price lunch after the high school biology course experience.

Socioeconomic level as indicated by qualification for free and reduced lunch did not show significance in any level of motivation. These students demonstrated statistically the same levels of motivation as students who did not qualify for free or reduced-price lunch. Therefore, the null hypothesis was accepted for research question number four and the alternative hypothesis was rejected.

Research Question Five Findings and Recommendations

Research question five was "What if any correlation exists between the type of motivation type reported by students and success in learning biology as measured by the Minnesota Comprehensive Assessment?"

The null hypothesis and alternative hypothesis for research question three were:

$H5_0$: There is no correlation between the type of motivation reported by students and their success on the Minnesota Comprehensive Assessment in Science.

$H5_a$: There is a correlation between the type of motivation reported by students and their success on the Minnesota Comprehensive Assessment in Science.

The correlation was measured by individual ANOVA tests and showed significance in correlations of both atrinsic motivation with a p-value of 0.001 and in extrinsic social motivation with a p-value of 0.003. Intrinsic motivation appears to visually have some correlation but is not significant with a p-value of 0.059. Extrinsic career motivation did not correlate with Minnesota Comprehensive Assessment scores. Extrinsic career motivation also did not correlate with course type in research question number one. It may be that students in high school do not always associate careers with the motivation to learn the science needed to succeed in them. They may not yet understand that to participate in a science career, it is important to be motivated to study the science itself. According to Rothberg (2006), the gap between student goals and their actual achievements grew over the 25-year period from 1976 to 2000. High school and college students often have unrealistic expectations about the type of work they hope to do and how hard they have to work to get there.

The hypothesis was that there would be correlations with motivation type and MCA scores. This was supported by the results of atrinsic motivation in which a negative correlation with MCA score was identified and extrinsic social motivation in which a positive correlation with MCA score was identified. Although intrinsic motivation and extrinsic career motivation did not show any significant correlation with MCA scores, the null hypothesis was rejected since both atrinsic motivation and extrinsic social motivation showed statistically significant correlation.

The MCA tests, although shown to be a valid and reliable measure of the Minnesota state standards are not required tests for high school graduation and are sometimes not regarded by students as being personally important (Armstrong, 2013). The Minnesota Comprehensive

Assessments are designed for system accountability and not as a measure for individual student achievement. However, if a student is motivated to learn and has done well, they may be motivated to show that learning on a test such as the MCA. Often when a student is confident in the material they are much more likely to take a test of that material seriously for the pure satisfaction of doing well with it and for the intrinsic motivation they have developed (Aydin et al., 2014; Boaler, 2016). Therefore, the MCA test may not be truly a test of ability but rather a reflection of motivation, particularly in students who struggle.

Implications

The honors biomedical science course is a relatively new way of teaching biology. As a hybrid of the PLTW Principles of Biomedical Science curriculum and the traditional honors biology curriculum, instruction is based on facilitation rather than direct instruction. Students work in groups and collaborative teams more frequently, there is a high inquiry element and the learning is centered on a real-life scenario involving human patients and diseases (PLTW, 2016). This type of learning appears to be less atrinsically motivating for all students. Only a small number of students reported that they were not motivated to learn. According to the results of the study, young women appear especially motivated. Whether it was the course that motivated them or if they chose the course because of their initial motivation, the result was the same. Young women reported that they were highly motivated intrinsically and extrinsically in the biomedical science course. They found the course interesting on both a personal level intrinsically and on levels related to both social and career motivation. This finding has been reported previously in studies involving the motivation and career selections of young women

(Gurian & Stevens, 2004). However, there is some concern that the young men in the group are not as highly motivated. More research may be necessary to ascertain why this is so.

African American (Black) students appear to struggle more with atrinsic motivation than other students do in this study. This has been reported in the literature (Evans, 2012; Mosweunyan, 2013). Currently the school district in which this study was done was undergoing external evaluation for possible cultural bias in discipline (Boese, 2015). Whether or not this investigation has merit, it may have undermined trust in the system and may be leading to negative levels of motivation in some African American students.

Although the numbers are small at only 14 total students in the study (two in Honors Biology, eight in Biomedical Science, and four in Regular biology), Hispanic students had lower levels of extrinsic career motivation than other groups of students. This result was indicated by an ANOVA statistical test that determines the probability of a difference between groups and not intentionally between any two specific groups. However, it may be prudent for educators to consider that there could be cultural bias in a student's consideration of possible future career opportunities. The results suggest that Hispanic students have less motivation to learn biology to participate in careers in biomedical science than other groups. Even though the sample size is not large enough for this to be significant by t-test alone, it may suggest that educators need to look for and provide more role models that all students can identify with in this area. Perhaps if all students are better able to envision themselves in these careers they will be more motivated to the possibility of pursuing them. Studies indicate that factors that influence career choice in Hispanic students include previous opportunity to learn science, self-efficacy or confidence in their own ability to learn science, and socio-culture factors such as peer and family influence on career possibilities (Crisp & Nora, 2012). In a study by Feur (2009), the discrepancy between student aspirations and expectations was explored. Hispanic student were frequently plagued with low expectations for future success in careers. Although nearly impossible to untangle the effect of poverty from the effect of ethnicity, research has indicated that expectations can influence final successful educational outcome and career success (Feur, 2009).

Asian students had high levels of extrinsic motivation and low levels of atrinsic motivation. They appear highly motivated to do well in educational course work. This correlates with what has been reported in past cultural studies (Hurley, Allen, & Wade-Boykin, 2009; Levinsohn, 2007).

Students in poverty showed similar levels of motivation to other students. However, their scores on the MCA standardized test were significantly lower than students who were not qualified for free or reduced-price lunch. This suggests that there may be a disparity in opportunity that is reflective of either preparation for school or stress (NIH, 2012) and may not be a factor in a student's desire to learn.

Recommendations for Practitioners

In this study the young women in the biomedical science course demonstrated significant positive levels of motivation in intrinsic and extrinsic social motivation and significant negative values in atrinsic motivation to learn biology. Recent research on career choices for young women has indicated a disparity in the number of women who choose engineering and computer science as careers as opposed to careers in biology and biomedical science. In a recent study by Cheryan (2017), it was found that stereotypes are the number one reason that young women do not choose these careers. On the other hand, biology, chemistry, and biomedical science have growing proportions of young women entering these fields. Research indicates that women prefer studying subjects and choosing careers in areas with a high human content (Gurian & Stevens, 2004; Smith, Brown, & Thoman, 2015). They are interested in contributing to the well-being of people in the world and solutions to world problems affecting them. Biomedical science is an obvious choice. However, the way it is taught may contribute to the perceived perspective of these young women. This disparity is actively being evaluated and studied in both education (PLTW, 2016) and career arenas (Cheryan, 2017). The current study suggests that young women appear more motivated to study biomedical science than young men do. The reasons for this are many but it may be that the relevant approach and cooperative learning found in this approach may be very effective. It may be worthwhile to consider this approach in other science classes in which young women have not shown as much enthusiasm. It is also worthwhile to consider why young men are not as enthused as young women in this area. Although the young men did not score significantly below other groups in types of motivation, they were not as positively motivated as the young women in the biomedical science course.

Ethnicity appears to play a role in motivation and ultimately in successful learning. It is critical that educators understand how to work with different groups of students and influence motivation through cultural norms (Evans, 2012; Mosweunyan, 2013). Black students who were high in atrinsic motivation may benefit from the approach found in the biomedical science course as opposed to the regular biology course, as this course seems to have the lowest levels of atrinsic motivation. It is also important that students see role models that they can relate to in various professions and in teaching (Crisp & Nora, 2012; Mosweunyan, 2013).

Honors courses attract highly motivated students or at least parents who are highly motivated (Lyman & Luther, 2014). This is to be expected as students choose these courses because they are more rigorous and go beyond the minimum requirements for graduation. For these reasons more students take these courses because they are college bound and have been told they will improve their chances for successfully being accepted to college. Teachers who are very motivated in their field are also frequently attracted to these courses (O'Brien-Stanford, 2013). This is unfortunate as the student most needing help in positive motivation may in fact have chosen to enroll in the non-honors level courses. One recommendation that may be important to increase student motivation and learning is to place teachers equally among courses and purposely place highly motivated teachers into all courses including those with more unmotivated students.

Recommendations for Academics

There are several areas of this study that need further research. It would be interesting to determine if the motivational differences between instructional methodology as seen in these different courses are the result of motivated students choosing these courses or if it is the course itself that motivates the students. It may in fact be a combination of the two. However, the extent of each would be beneficial in making recommendations for student educational choices in the future. It would also be interesting to measure the level of engagement within and between these courses. Although not addressed in this study, it has been observed that classroom management challenges are different within the regular biology classes and the honors biology classes then they are with the honors biomedical science classes. The possibility exists that classroom management issues are also the outcome of teaching method and/or the individual class relevancy and application. Student boredom is one of the strongest predictors of classroom management issues. When students are fascinated with the material and are challenged appropriately, classroom management issues decrease significantly (Giancola, 2000; Linsin, 2011).

The highest proportion of student motivation was reported by the ninth-grade female students who chose to take the honors biomedical science course. The PLTW course appears to attract and develop highly motivated young women who seem eager to consider careers in the field of biomedical science and work hard to learn the subject matter. As reported in other studies, young women are attracted to and motivated by subjects and careers that directly affect human beings and benefit the greater good (Gurian & Stevens, 2004; Smith, Brown, & Thoman, 2015). They perceive biomedical science as fulfilling this need but do not always see other areas of science as favorably. Although there has been concern and some success recently in both the education of women in varied areas of science (PLTW, 2016) and in their level of job satisfaction (Cheyan, 2017; Koul, 2012), more study is still needed and would be appropriate and highly beneficial in this time of need for increased science talent. Young men reported significantly lower levels of motivation than the young women in areas of intrinsic motivation and extrinsic social motivation and they also had a significantly increased level of atrinsic motivation when compared to the young women in this course. Further research needs to be done in this area to ascertain not only the best methodology for young women but for young men as well.

The students in this study were in the ninth-grade at the time of the study and taking their first biology course at the high school level. In many high schools, students take their biology class in the tenth-grade. It is known that children mature considerably during this time in their lives and it is possible that their feelings toward learning may mature as well. This may be especially evident for the young men in this study (Koul, 2012). Would the results be different if the students were older?

There were three female teachers and one male teacher who participated in this study. Could the gender of the teacher affect the results of motivation? Young students have been shown to be highly influenced by role models and stereotypes in gender (Cheryan, 2017; Koul, 2012). It is possible that the gender of the teacher may affect the motivation a student has to study the subject with that teacher.

There are differences in motivation correlated with ethnicity. The strongest differences are found in Black students who show high levels of atrinsic motivation and Hispanic students who show low levels of extrinsic career motivation. Although the honors biomedical science students discuss careers as part of their curriculum they do not appear to have significantly higher levels of extrinsic career motivation than students in other courses. These are areas that are of concern and should be studied more thoroughly with increased numbers of students. It may be that a lack of role models in these areas contributes to difficulty in students seeing themselves in these careers and areas of study (Schutte, 2015). This may be at least partially responsible for this finding.

Finally, of concern, are students living in poverty and black female students. Although both groups reported that they are just as motivated as other students to learn science, they have done poorly on standardized tests in this study and in the past (MDE, 2017). Whether this is a problem with opportunity or if there are other concerns, it is paramount that further research be done to develop ways to better understand and meet the needs of these students.

Concluding Comments

To learn, students must be motivated to do so. Motivation comes in a variety of forms including intrinsic motivation, extrinsic career motivation, extrinsic social motivation, and atrinsic motivation or a lack of motivation (Aydin, 2015).

There are differences in the way and means by which students are motivated. In the high school in which this study was conducted, there were three possible courses for meeting biology graduation requirements and these courses involved different instructional methods. Students could choose the regular biology course, the honors biology course, or a biomedical science honors course. At the end of the courses it was found that young women were especially motivated in the biomedical science course. Currently there is a push to increase female student participation in PLTW engineering and computer science programs. In 2008 the proportion of young women in the PLTW engineering courses was 17%. In the same year in the biomedical sciences courses representation by young women was 38% (Kingsbury, 2010). In this study the proportion of young women in the biomedical science was 65% as compared to the honors biology class with 45% young women, and the regular biology class with 45%. Whether these courses attracted these students in the first place or whether they helped to promote and develop their motivation, the result is indistinguishable, but the gender ratio suggests that course selection does play a role.

It is prudent at this point in human development that we consider the implications of the teaching methodology and career stereotypes so that all students will at least consider careers in science. The teaching and learning style seen in the biomedical science course may be applicable to other courses where young women are not as strongly represented. However, it is not yet certain whether this effect is due to the social and personal perspective of the course, the actual interest in biomedical research, or the collaborative approach to learning. Although a correlation is apparent, more research is needed to determine cause and effect.

The biomedical science course may also be especially applicable to groups of students who report high levels of atrinsic motivation. The relevancy and inquiry in the course seems to demonstrate that students feel less atrinsic motivation than they do in other courses. There are also differences in motivation correlated with ethnicity. The strongest differences are found in Black students who show high levels of atrinsic motivation and Hispanic student who show low levels of extrinsic career motivation. Finally, of concern, are students living in poverty and Black female students. Although both groups reported that they are just as motivated as other students to learn science, they have done poorly on standardized tests in the subjects (MDE, 2017).

The motivation to learn is a critical aspect of science education. Without the desire to understand, appreciate science, and become actively involved in it, it is difficult if not impossible to experience academic success in the field and consider future learning and possible careers. Understanding student motivation and the factors that contribute to it can do a great deal for the success of students in these critical areas of study.

References

American Association for the Advancement of Science. (1993). *Benchmarks for science literacy.* Oxford, England: Oxford University Press.

Anderson, L.W., & Krathwohl, D. (2011). *A taxonomy for learning, teaching, and assessing: a revision of Bloom's taxonomy of educational objectives*. NY: Longman. Retrieved from http://discoverlibrary.vanderbilt.edu/primo_library/libweb/action/display.do;jsessionid=9E10D258AA6C1388F7E69A318A8D40C3?tabs=detailsTab&ct=display&fn=search&doc=vanunicorn2453902&indx=1&recIds=vanunicorn2453902&recIdxs=0&elementId=0&renderMode=poppedOut&displayMode=full&frbrVersion=&vl(78204569UI0)=any&query=any%2Ccontains%2C0321084055&search_scope=Unicorn&dscnt=0&scp.scps=scope%3A%28vanunicorn%29&vl(1UIStartWith0)=contains&vid=VANDERBILT&onCampus=true&institution=VAN&bulkSize=10&tab=acorn&vl(freeText0)=0321084055&dstmp=1489341552378

Armstrong, T. (2013, February). *15 reasons why standardized tests are worthless*. American Institute for Learning and Human Development. Retrieved from http://institute4learning.com/blog/2013/02/28/15-reasons-why-standardized-tests-are-worthless-2

Aydin, S., Yerdelen, S., Gurbuzuglo, S., Yalmanci, S., & Goksu, V. (2014). Academic motivation scale for learning biology: a scale development study. *Education and Science*, TEDMEM, *39*(176) 425-435. Retrieved from https://www.researchgate.net/publication/279035671_Academic_Motivation_Scale_for_Learning_Biology_A_Scale_Development_Study

Aydin, S. (2015). An analysis of the relationship between high school students' self-efficacy, metacognitive strategy use and their academic motivation for learning biology. *Journal of Education and Training Studies*. *4*(2) 53-59.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*. *84*(2) 191-215.

Boaler, J. (2016). *Mathematical mindsets: unleashing students' potential through creative math, inspiring messages, and innovative teaching*. Jossey-Bass. Hoboken, NJ.

Boese, B. (2015, November). OCR report: Black students face discipline disparity in Rochester school. *Rochester Post Bulletin*. Retrieved from http://www.postbulletin.com/news/local/ocr-report-black-students-face-discipline-disparity-in-rochester-schools/article_ecb5d7fa-5b0b-59c7-b6a2-4fabd813ba4a.html

Bowman, L. & Govett, A. L. (2015). Becoming the change: A critical evaluation of the changing face of life science, as reflected in the NGSS. *Science Educator, 24*(1), 51-61. Retrieved from https://search-proquest.com.ezproxy.bethel.edu/docview/1698103093?accountid=8593

Burton, E. M. (2007). *Extended school day. research brief.* Education Partnerships, Inc. Retrieved from https;//files.eric.ed.gov/fulltext/ED537590.pdf

Bybee, R. W., Taylor, J. A., Gardner, A., Van Scotter, P., Powell, J. C., Westbrook, A. & Lades, N. (2006). *The BSCS 5E instructional model: origins and effectiveness.* Office of Science Education, National Institutes of Health. Retrieved from https://bscs.org/sites/default/files/_legacy/BSCS_5E_Instructional_Model-Full_Report.pdf

Caine, R.N., Caine, G., McClintic, C., & Klimek, K. (2016). *12 Brain/Mind learning principles in action: teach for the development of higher order thinking and executive function 3rd edition*. Thousand Oaks, California: Corwin.

Cheryan, S. (2017, January). Why Are Some STEM fields more gender balanced than others? *Psychological Bulletin*. *143*(1) 1-35.

Coutts, R., Gilleard, W., & Baglin, R. (2011). Evidence for the impact of assessment on mood and motivation in first-year students. *Studies in Higher Education. 36*(3), 291-300.

Crisp, G., & Nora, A. (2012, July), *Overview of Hispanics in science, mathematics, engineering, and technology (STEM); K-16 representation, preparation, and participation*. Hispanic Association of Colleges and Universities. Retrieved from http://www.hacu.net/images/hacu/OPAI/H3ERC/2012_papers/Crisp%20nora%20-%20hispanics%20in%20stem%20-%20updated%202012.pdf

Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience.* New York, NY: Harper and Row.

DaGiau, B. J. (1997). *A program of counseling and guidance to facilitate the transition from middle school to high school.* Retrieved from https://files.eric.ed.gov/fulltext/ED413562.pdf

Duckworth, A. (2016). *Grit: The Power of Passion and Perseverance*. New York, New York: Scribner.

Dweck, C., Walton, G., & G. Cohen. (2014). *Academic tenacity; mindsets, and skills that promote long-term learning*. Bill and Melinda Gates Foundation. Retrieved from www.gatesfoundation.org

Eichenbaum, A., Bevelier, D., & Green, C.S. (2014). Video games: Play that can do serious good. *American Journal of Play*. *7*(1). Retrieved from https://files.eric.ed.gov/fulltext/EJ1043955.pdf

Evans, D. E. (2012). *A Study of African American student trust and engagement in high school (Doctoral dissertation).* Retrieved from http://www.proquestion.com/e-US/products/dissertations/individuals.shtml

Froiland, J. M., Oros, E., Smith, L., & Hirchert, T. (2012). Intrinsic motivation to learn: The nexus between psychological health and academic success. *Contemporary School Psychology, 16*, 91-100.

Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences*. New York: Basic Books Inc.

Gardner, H. (1991). *The unschooled mind: How children think and how schools should teach*. New York: Basic Books Inc.

Gassama, S. (2012, March 28). The correlation between poverty and learning: What can be done to help children with limited resources learn. *Ed.gov: Institute of Education Sciences*. Retrieved from https://eric.ed.gov/?id=ED530618

Giancola, S. P. (2000). Adolescent behavior problems: Peer pressure "Is" all it is cracked up to be. *ERIC/CASS virtual library*. Retrieved from www.ericcass.uncg.edu/virtuallib/violence.9008.html

Gillet, N., Vallerand, R. J., & Lafreniere, M. K. (2012). Intrinsic and extrinsic school motivation as a function of age: The mediating role of autonomy support. *Social Psychology of Education: An International Journal, 15*(1), 77-95.

Gray, P. (2008, August). A brief history of education. *Psychology Today.* Retrieved from https://www.psychologytoday.com/blog/freedom-learn/200808/brief-history-education

Gregory, G. & Kaufeldt, M. (2015). *The motivated brain; Improving student attention, engagement, and perseverance.* ASCD Press. Alexandria, Virginia.

Groeneveld, E. (2016, December 9). Prehistoric hunter-gatherer societies. *Ancient History Encyclopedia.* Retrieved from: http://www.ancient.eu/article/991/

Gurian, M. & Stevens. K. (2004). With boys and girls in mind. *Educational Leadership 62*(3): 21-26. Retrieved from http://www.ascd.org/publications/educational-leadership/nov04/vol62/num03/With-Boys-and-Girls-in-Mind.aspx

Hammer, K. & Alphonso, C. (2017, March). Educators still trying to attract more women to technology, science fields. *The Globe and Mail*. Retrieved from https://www.theglobeandmail.com/news/national/education/educators-still-trying-to-attract-more-women-to-technology-science-fields/article20955071/

Herr, N. (2007). National science education standards. *Internet Resources to Accompany: The Sourcebook for Teaching Science.* Retrieved from https://www.csun.edu/science/ref/curriculum/reforms/nses/

Hikosaka, O. (2010, July). The habenula: From stress evasion to value based decision making. *National Review of Neuroscience*. *11*(7): 503-513. Retrieved from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3447364/

Huang, H. (2015). Can students themselves narrow the socioeconomic-status-based achievement gap through their own persistence and learning time? *Education Policy Analysis Archives, 23*(108).

Hunter, J. C. (2014). Reflecting on lab practices. *Education, 134*(3), 380-383.

Hurley, E. A., Allen, B.A., Wade Boykin, A. (2009). Culture and the interaction of student ethnicity with reward structure in group learning. *Cognition and Instruction*. *27*(2) 121-146.

Jones, B. D., Chittum, J. R., Akalin, S., Schram, A. B., Fink, J., Schnitka, C., & Brandt, C. (2015). Elements of design-based science activities that affect students' motivation. *School Science and Mathematics, 115*(8), 404-415.

Knewton, (2017, April). *Knewton Informatics: Gamification*. Retrieved from https://www.knewton.com/infographics/gamification-education/

Kohn, A. (2011). The case against grades. *Educational Leadership, 69*(3), 28-33.

Koul, R., Roy, L., & Lerdpornkulrat, T. (2012). Motivational goal orientation, perceptions of biology and physics classroom learning environments, and gender. *Learning Environments Research, 15*(2), 217-229.

Laerd Statistics. (2017). *One-way MANOVA in SPSS statistics*. Retrieved from statistics.laerd.com

Lai, E. (2011, April). *Motivation: A Literature Review*. Pearson. Retrieved from http://images.pearsonassessments.com/images/tmrs/Motivation_Review_final.pdf

Lee, J. Q., McAnarney, D. M., Liem, G. A. D., & Ortiga, Y. P. (2010). The relationship between future goals and achievement goal orientations: An intrinsic-extrinsic motivation perspective. *Contemporary Educational Psychology, 35*(4), 264-279.

Levinsohn, K. R. (2007). Differences and learning styles of Chinese and European trades students. *Institute for Learning Styles Journal*. Vol. 1. Retrieved from http://www.auburn.edu/academic/education/ilsrj/Journal

Lin-Siegler, X., Ahn, J. N., Chen, J., Fang, F. A., & Luna-Lucero, M. (2016). Even Einstein struggled: Effects of learning about great scientists' struggles on high school students' motivation to learn science. *Journal of Educational Psychology. 108*(3) 314-328.

Linsin, M. (2011, September 24). Are you boring your students into misbehavior? 2018 Smart Classroom Management. Retrieved from: https://www.smartclassroommanagement.com/2011/09/24/bored-students-misbehave/

Lyman, E. L., & Luthar, S. S. (2014). Further evidence on the 'costs of privilege': Perfectionism in high-achieving youth at socioeconomic extremes. *Psychology in the Schools, 51*(9), 913-930. doi:10.1002/pits.21791

Margalit, L., (2015, August 7). Why are the Candy Crushes of the world dominating our lives*?* *Psychology Today*. Retrieved from https://www.psychologytoday.com/blog/behind-online-behavior/201508/why-are-the-candy-crushes-the-world-dominating-our-lives.

Marzano, R. J., & Heflebower, T. (2011). Grades that show what students know. *Educational Leadership, 69*(3), 34-39.

Maslow, A. H. (1954). Motivation and personality. New York: Harper and Row.

McCollough, C. A. (2011). Creating a college-going culture. *Science Teacher, 78*(3), 51-55.

McLoed, S. (2016). Maslow's hierarchy of needs. *Simply Psychology*. Retrieved from http://www.simplypsychology.org/maslow.html

Minnesota Department of Education (2012). *Science standards*. Minnesota Department of Education. Retrieved from http://education.state.mn.us/MDE/Data/index.html

Minnesota Department of Education (2017). *Data center*. Minnesota Department of Education. Retrieved from http://education.state.mn.us/MDE/Data/index.html

Minnesota Department of Education (2017). *School report card*. Minnesota Department of Education. Retrieved from http://rc.education.state.mn.us/#demographics/orgId--10535305000__p--1

Mirel, J. (2006, Winter). The traditional high school: Historical debates over its nature and function. *Education Next*. 6(1). Retrieved from http://educationnext.org/the-traditional-high-school/

Mosweunyane, D. (2013). The African educational evolution: From traditional training to formal education. *Higher Education Studies, 3*(4), 50-59.

Moulding, B., Bybee, R. & N. Paulson. (2015). *A vision and plan for science teaching and learning; An educator's guide to a Framework for K-12 Science Education, Next Generation Science Standards, and State Science Standards.* USA: Essential Teaching and Learning Publications.

National Academy of Science. (1996). *Science education standards*. Washington D.C.: National Academy Press.

National Board of Professional Teaching Standards. (2016). *Science standards (3rd ed).* Retrieved from http://boardcertifiedteachers.org/sites/default/files/EAYA-SCIENCE.pdf

National Institutes of Health. (2012, August 28). *Stresses of poverty may impair learning ability in young children.* U.S. Department of Health and Human Services. Retrieved from https://www.nih.gov/news-events/news-releases/stresses-poverty-may-impair-learning-ability-young-children

National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

National Science Teachers Association. (2004. September). *Talking points*. NSTA. Retrieved from: static.nsta.org/pdfs/TalkingPoints15pp.pdf

Next Generation Science Standards - NGSS. (2013). *Next generation science standards: For states, by states*. Washington, DC: The National Academies Press.

O'Brien-Stanford R. (2013, April 24). Low-achieving students don't get top teachers. *Education*. Stanford University. Retrieved from: https://www.futurity.org/low-achieving-students-dont-get-top-teachers/

Osborne, F. (2017). EMSE 3230-5230. *Brief history of science education in the United States*. Retrieved from http://www.kean.edu/~fosborne/E3230/E3230-03History.html

Panksepp, J. & Biven, L. (2012*). The archaeology of mind: Neuroevolutionary origins of human emotions.* New York, New York: W.W. Norton & Company.

Picho, K., & Stephens, J. M. (2012). Culture, context and stereotype threat: A comparative analysis of young Ugandan women in coed and single-sex schools. *Journal of Educational Research, 105*(1), 52-63.

Pittinsky, T. L., & Diamante, N. (2015). Going beyond fun in STEM. *Phi Delta Kappa, 97*(2), 47-51.

Planchard, M., Daniel, K. L., Maroo, J., Mishra, C., & McLean, T. (2015). Homework, motivation, and academic achievement in a college genetics course. *Bioscene: Journal of College Biology Teaching, 41*(2), 11-18.

Preckel, F., Lipnevich, A. A., Boehme, K., Brandner, L., Georgi, K., Konen, T., Roberts, R. D. (2013). Morningness-eveningness and educational outcomes: The lark has an advantage over the owl at high school. *British Journal of Educational Psychology, 83*(1), 114-134.

Project Lead the Way. (2016). *Principles of biomedical science curriculum*. Retrieved from http://www.mypltw.org

Project Lead the Way. (2017). *Our approach*. Retrieved form https://www.pltw.org/about-us/our-approach

Randler, C., Rahafar, A., Arbabi, T., & Bretschneider, R. (2014). Affective state of school pupils during their first lesson of the day- Effect of morningness-eveningness. *Mind, Brain, and Education, 8*(4), 214-219.

Richtel, M. (2012, Nov. 1). Technology changing how students learn, teachers say. *The New York Times. Education*. Retrieved from http://www.nytimes.com/2012/11/01/education/technology-is-changing-how-students-learn-teachers-say.html

Rivera, Y.S. (2010). *Promoting motivation through mode of instruction: The relationship between use of affective teaching techniques and motivation to learn science.* (Doctoral thesis, Lehigh University). Retrieved from http://search.proquest.com.ezproxy.bethel.edu/docview/503249408/fulltextPDF/5E0212302 7374A78PQ/1?accountid=8593

Robinson, M., & Ochs, G. T. (2008). Determining why students take more science than required in high school. *Bulletin of Science, Technology & Society, 28*(4), 338-348.

Rochester Public Schools. (2016). *Registration guide*. Retrieved from http://www.rochester.k12.mn.us/

Rothberg, S. (2006, November 29). High school students have unrealistic career expectations. *College Recruiter*. Retrieved from https://www.collegerecruiter.com/blog/2006/11/29/high-school-students-have-unrealistic-career-expectations/

Schweinle, A. & Helming, L.M. (2011). Success and motivation among college students. *International Education*. *42*(2), 529-546. doi 10.1007/s11218-011-9157-z

Shumow, L., Schmidt, J. A., & Zaleski, D. J. (2013). Multiple perspectives on student learning, engagement, and motivation in high school biology labs. *High School Journal, 96*(3), 232-252.

Schütte, K. (2015). Science self-concept and valuing science: A cross-cultural analysis of their relation among students from western and East Asian countries. *Social Psychology of Education: An International Journal, 18*(4), 635-652.

Shaunessy-Dedrick, E., Suldo, S. M., Roth, R. A., & Fefer, S. A. (2015). Students' perceptions of factors that contribute to risk and success in accelerated high school courses. *High School Journal, 98*(2), 109-137.

Shumow, L., Schmidt, J. A., & Zaleski, D. J. (2013). Multiple perspectives on student learning, engagement, and motivation in high school biology labs. *High School Journal, 96*(3), 232-252.

Smith, J. L., Brown, E. R., Thoman, D. B., & Deemer, E. D. (2015*).* Losing its expected communal value: How stereotype threat undermines women's identity as research scientists. *Social Psychology Education*, *18*(3), 443–466. doi:10.1007/s11218-015-9296-8

Spearman, J., & Watt, H. M. G. (2013). Perception shapes experience: The influence of actual and perceived classroom environment dimensions on girls' motivations for science. *Learning Environments Research, 16*(2), 217-238.

Stiggins, R., & Chappuis, S. (2005). Putting testing in perspective: It's for learning. *Principal Leadership, 6*(2), 16-20.

Tabaco, M. & Dennick, R. (2011). Making sense of Cronbach's alpha*. International Journal of Medical Education*. 2:53-55. doi: 10.5116/ijme.4dfb.8dfd

Taylor, J. (2014). Evidence of deeper learning outcomes: Findings from the study of deeper learning. *Society for Research on Educational Effectiveness*. Retrieved from https://eric.ed.gov/?id:ED562705

Tokuhama-Espinosa, T. (2016). A brief history of the science of learning (part 1 3500 B.C.E to 1970 C.E.). *Johns Hopkins School of Education*. Retrieved from http://education.jhu.edu/PD/newhorizons/Journals/Winter2011/Tokuhama4

University College Dublin – UCD. (2017)*. Education theory: Constructivism and social constructivism. Open education resources of UCD teaching and learning*, University College Dublin. Retrieved from http://www.ucdoer.ie/index.php/Education_Theory/Constructivism_and_Social_Constructivism

U.S. Department of Education. (1983). *A nation at risk*. Retrieved from https://www2.ed.gov/pubs/NatAtRisk/risk.html

U.S. Department of Education. (2017). *No child left behind - NCLB*. Retrieved from https://www2.ed.gov/nclb/landing.jhtml

U.S. Department of Education. (2017). *Every Student Succeeds Act – ESSA*. Retrieved from https://www.ed.gov/essa

U.S.N.E.I. (2008, Feb). *Organization of U.S. education: The school level.* International Affairs Office, U.S. Department of Education. Retrieved from http://www.ed.gove/about/offices/list/ous/interantion/usnei/edlite-index.html

Walker, T. (2014, November). Education policy: NEA survey: Nearly half of teachers consider leaving the profession due to standardized testing. *neaToday*. Retrieved from http://neatoday.org/2014/11/02/nea-survey-nearly-half-of-teachers-consider-leaving-profession-due-to-standardized-testing-2/

Wardle, J., Robb, K. & Johnson, F. (2017, April*). Assessing socioeconomic status in adolescents: The validity of a home affluence scale*. Retrieved from http://jech.bmj.com/content/56/8/595

Wessa, P. (2017). *Cronbach alpha (v1.0.5) in free statistics software (v1.2.1).* Office for Research Development and Education. Retrieved from https://www.wessa.net/rwasp_cronbach.wasp/

Appendix A

Student Survey

No.		Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
1	I enjoy learning biology.						
2	I want to get a good job in the field of biology so I need to do well in this course.						
3	I want to be praised by the people around me.						
4	I want to get accepted at competitive colleges and universities, so I need to do well in biology.						
5	I want to show my family that I'm successful in biology.						
6	Biology interests me.						

7	I enjoy sharing new things that I learn in biology with others.						
8	I have no idea why I’m taking biology. I don't understand how the things I learn could be useful to me.						
9	Learning new things about the biology subjects that I am interested in is enjoyable.						
10	I enjoy taking part in discussions on biology subjects.						
11	Biology is related to the profession that I chose for my future so I need to do well in this course.						

12	In fact, I don't like participating in biology activities						
13	I want to prove to myself that I can learn biology.						
14	Actually, I don't think the subjects that I learn will be useful for me in the future.						
15	Biology is important in my choice of profession so I need to do well in this course.						
16	Honestly, I don't know why I should learn biology.						
17	I enjoy reading magazine articles and textbooks about topics in biology.						
18	I want to show that I'm better than the other						

	students.						

For each question a six-point Likert scale was used ranging from strongly agree to agree to somewhat agree to somewhat disagree to disagree to strongly disagree. These were given a value of 1 for strongly agree to 6 for strongly disagree. These scores were averaged by category.

The analysis was based on the categories of Intrinsic Motivation (questions 1, 6, 7, 9, 10, 17), Amotivation (questions 8, 12, 14, 16), Extrinsic – Social Motivation (questions 2, 4, 11, 15), and Extrinsic Career Motivation (questions 3, 5, 13, 18). A mean score for each category was determined to ascertain the prevalent motivational style of the student.

Appendix B

Student Survey – Demographics

Biology class currently being taken:

- ❍ Regular High School Biology
- ❍ Honors Biology
- ❍ Biomedical Science Honors

Gender (sex):

- ❍ Male
- ❍ Female

Ethnicity or Culture:

- ❍ Hispanic/Latino
- ❍ American Indian/Alaska Native
- ❍ Asian
- ❍ Black/African American
- ❍ Native Hawaiian/Pacific Islander
- ❍ White
- ❍ Other

Test Code:

- ❍ 4
- ❍ 3
- ❍ 2
- ❍ 1
- ❍ MCA Test was not taken

Grade:

- ❍ 9
- ❍ 10
- ❍ 11
- ❍ 12

Qualification for Free or Reduced Priced Lunch:

- ❍ Yes
- ❍ No
- ❍ I don't know

Appendix C

Consent Form

Dear Parent and Student,

You are invited to participate in a study of student motivation and course teaching strategies. This research will explore learning strategies and curriculum strategies that effectively motivate students to learn biological concepts. You were selected as a possible participant in this study because you are currently enrolled in one of the High School standards-based biology courses. This research is part of my dissertation work as a requirement for my doctoral degree in educational leadership at Bethel University.

If you decide to participate, I will provide you with a five-minute survey about how you feel about biology. This survey will be done during your biology class period. You will be asked to enter a code which represents your score category level (exceeds standards, meets standards, partially meets standards or does not meet standards). You will receive your score later in the summer when the school district releases them. You will also be asked for some basic demographic questions such as age, gender, ethnicity, and whether you are able to get a free lunch at school. You will then be provided 19 simple statements regarding how you feel about biology and ask you to rate them on a scale from one (strongly disagree) to six (strongly agree). Your responses will not be identifiable from those of other students. All responses will remain confidential and will be seen only as part of a large data base. In any written reports or publications, no one will be identifiable and only aggregate data will be presented. Your decision whether or not to participate will not affect your future relations with Bethel University or the High School. If you decide to participate, you are free to discontinue participation at any time without affecting such a relationship. This research project has been reviewed and approved by the Bethel University Institutional Review Board and Rochester Public School. If you have any questions about the research and/or research participants' rights, please email the researcher, Cheryl Moertel at chm83852@bethel.edu or chmoertel@rochester.k12.mn.us or the Bethel University faculty advisor, Dr. Patricia Paulson at patricia-paulson@bethel.edu. You will be offered a copy of this form to keep.

You are making a decision whether or not to participate. Your signature indicates that you have read the information provided above and have decided to participate. You may withdraw at any time without prejudice after signing this form should you choose to discontinue participation in this study. I truly appreciate your help. Your answers will allow me to learn more about the motivation students have in learning biological concepts and will help teachers to better provide effective learning opportunities for students. Thank you so very much for your help.

Cheryl Moertel, Researcher

Signature of Student____________________________________ Date ________________

Signature of Parent or Guardian ___________________________ Date _______________

Appendix D

Permission to use Motivation to Learn Biology Survey

Cheryl Moertel <chm83852@bethel.edu>	4/23/17

Dear Dr. Aydin,

I am a biology teacher who is working on her doctorate in education. I am interested in student academic motivation for learning biology and have designed classes to specifically enhance intrinsic motivation. I have been particularly influenced by the survey that you created with others to measure student motivation (intrinsic, extrinsic career, extrinsic social and atrinsic) and I would very much like to use it as a measure of my own student's motivation in these biology courses.

My dissertation involves the motivation of students after taking several different types of biology courses. I am also looking at motivation as it varies with regard to ethnicity, gender and socioeconomic status.

Would it be alright if I used your 19 question survey on motivation in biology for my study? I would appreciate this very much as I believe it is outstanding work and will do much to enhance my own work and learning.

Thank you for your consideration.

Cheryl Moertel
Bethel University
Minnesota, USA

sündüs Yerdelen <suyerdelen@gmail.com>	4/24/17

Hi Cheeyl,
Thanks for your interest to our bııology motivation scale. We would be happy if you use it in your dissertation. It is originally developed in Tırkish. English version is not validated yet. If you adapt it into English, we are more than happy.

Best,
Sündüs

24 Nis 2017 10:51 tarihinde "solmaz aydın" <solmazaydn@gmail.com> yazdı:

iPhone'umdan gönderildi

İleti başlangıcı: