THE EFFECT OF THE FLIPPED CLASSROOM ON URBAN HIGH SCHOOL STUDENTS' MOTIVATION AND ACADEMIC ACHIEVEMENT IN A HIGH SCHOOL SCIENCE COURSE

by

Keshia L. Dixon

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

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2017

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ABSTRACT

This study investigated the effect of the flipped classroom on urban high school students' motivation and academic achievement in a high school science course. In this quantitative study, the sample population was comprised of North Star High School 12th grade students enrolled in human anatomy and physiology. A quasi-experimental, pretest-posttest non-equivalent group design was conducted. After receipt of Liberty University Institutional Review Board approval and the school district's Department of Research and Evaluation for School Improvement, students completed a pretest comprised of the Science Motivation Questionnaire II (SMQ-II) and the Human Anatomy and Physiology Unit Test. Participants in the experimental group engaged in the treatment, the flipped classroom, using instructional materials on the educational website, Edmodo™, and applied content material taught using hands-on activities inclusive of assigned laboratory experiments. Participants in the control group received instruction using traditional face-to-face lecture-homework format while also engaging in assigned laboratory experiments. After the completion of the treatment all participants completed a posttest. Data from both the pretest and posttest was statistically analyzed individually using two separate one-way ANOVA/ANCOVA analyses; and researcher reported the results of the statistical analyses. After completion of the analyses, and interpretation of the results, recommendations for future research were given.

Keywords: academic achievement, blended learning, Edmodo, flipped classroom, gender, motivation, traditional classroom, STEM

Dedication

I would like to dedicate this body of work to my mother, Brenda Dixon, sisters, Jessica Williams and Tammy Dixon-Reynolds, and my love Michael Mosley. No words can honestly express how much I truly appreciate the support and love shown to me during this journey. I know that you have helped me to reach this goal through various means of assistance, whether it was lending your shoulder for me to cry on, listening to me vent, or cheering me on when I was ready to give up. My prayer is that you all understand and forgive me for the times I had to sacrifice to accomplish this goal. I am forever indebted to you all, and I share this milestone with you.

As for my guardian angel, my grandmother, may she continue to rest in paradise with our Heavenly Father. I made it across the finish line because she continuously watched over me. She guided me with her sweet gentle spirit and the light of persistence that will forever burn in my heart. She always knew that I would become the doctor she envisioned all her years here on Earth. Granny this is for you and our family! My hope is that I made you proud.

Acknowledgements

I would like to express my deepest appreciation to Dr. Jillian Wendt, my committee chair, who pushed and challenged me to be the very best while embarking on this journey. This was not the easiest process for me, and through it all you continued to encourage me not to give up. You allowed me to express not only the good, but also the many fears I expressed to you about this process and my family. I hope you are proud of this final product, and look forward to what is to come while working on future projects.

Thank you, Dr. Megan Cordes and Dr. Donavan Outten, for agreeing to serve as committee members. Your expertise, time, encouragement, and words of wisdom were invaluable. It is because of you that I was able to create a solid product.

A sincere thank you to Nate Sanders, who was the calm after the storm when all doubt crept in my mind. You allowed me to see light when there was only darkness. Your expertise in making me see statistics through your eyes helped me enormously.

To my students who allowed me to complete the many revisions and meet the many deadlines I say THANK YOU!! The cheers and support from you all is overwhelming. Without you all I assuredly would not be at this junction.

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Abbreviations

Advanced Placement (AP)

Analysis of covariance (ANCOVA)

Analysis of variance (ANOVA)

Basic Needs Theory (BNT)

Causality Orientations Theory (COT)

Central Limit Theorem (CLT)

Cognitive Evaluation Theory (CET)

Committee on Equal Opportunities in Science and Engineering (CEOSE)

Flipped Learning Network (FLN)

General Accounting Office (GAO)

Georgia Standards of Excellence (GSE)

Goals Content Theory (GCT)

Gross Domestic Product (GDP)

Historically Black College and University (HBCU)

Institutional Review Board (IRB)

Organismic Integration Theory (OIT)

National Assessment of Educational Progress (NAEP)

National Center on Education and Economy (NCEE)

National Center for Education Statistics (NCES)

National Science Foundation (NSF)

Organisation for Economic Cooperation and Development (OECD)

Problem-based learning (PBL)

Program for Exceptional Children (PEC)

Public Broadcasting System (PBS)

Science Motivation Questionnaire-II (SMQ-II)

Self-Determination Theory (SDT)

Social Cognitive Theory (SCT)

Social Learning Theory (SLT)

Science, technology, engineering, or mathematics (STEM)

Thyroid Stimulating Hormone (TSH)

Underrepresented minorities (URMs)

United States (U.S.)

United States Bureau of Labor Statistics (BLS)

CHAPTER ONE: INTRODUCTION

Overview

Less than one in seven students in the United States (U.S.) obtain a degree in science or engineering in comparison to one out of two in China and one out of three in Singapore (Soldner, Rowan-Kenyon, Inkelas, Garvey, & Robbins, 2012). As a result of the low number of students receiving degrees in science, technology, engineering, or mathematics (STEM) a deficit developed in the number of students entering STEM career fields. In a study conducted by the U. S. Department of Education (2007) and the U.S. Department of Labor (2015) it was found that approximately eight out ten of the fastest growing career fields from 2012-2022 require significant training in science or mathematics. Over a ten year time span (2000-2010), STEM employment grew by 7.9% versus non-STEM employment of 2.6%, and the projected growth from 2008 to 2018 more than doubles to 17% for STEM employment in comparison to 9.8% for non-STEM employment (Langdon, McKittrick, Beede, Khan, & Doms, 2011). Despite the awareness of the training needed for the growing career fields the U. S. is continuing to experience a large deficit in students entering STEM career fields (Foltz, Gannon, & Kirschmann, 2014). STEM employees are important in establishing and maintaining the stability of the economy of the U. S. (Langdon et al., 2011). Over time, research studies have been conducted in an effort to comprehend the reasons surrounding the gap in students entering STEM fields (Foltz et al., 2014; National Science Board, 2007; National Science Foundation, 2009). For instance, the National Academies (2007) found the small percentage of STEM degrees being produced were contributing to the STEM deficit that is threatening the country's capability to successfully compete in an international economy. The concern of the deficit centers on the inability to attain persons desiring to enroll in STEM courses and STEM fields, and to stabilize the attrition rate of employees in STEM occupations.

While further examining the issue, a major problem of STEM attrition was more worrisome for specific student populations as opposed to others. According to the National Science Foundation (2009), despite the increase in females and minorities obtaining science degrees, an underrepresentation of females and minorities is still present in STEM majors and occupations. Beede et al. (2011) of the U. S. Department of Commerce Economics and Statistics Administration showed that in 2009 of the total number of workers with STEM jobs only 6% are comprised of Black (non-Hispanic) employees in comparison to 72% White (non-Hispanic). Degree completion for women and underrepresented minority students (not inclusive of Asian-Americans) are far less than the totality of undergraduates (National Science Board, 2007).

According to Museus, Palmer, Davis, and Maramba (2011), critical damage occurs prior to the collegiate years deterring minorities from selecting science and engineering majors or careers. Authors Museus et al. (2011) suggested that a way of improving the success of minority students in STEM is to find ways to determine and resolve the lack of academic preparation in primary and secondary education. For this to be accomplished, STEM education modifications in K-12 and postsecondary education and curriculum are needed (Becker & Park, 2011). Becker and Park (2011) indicated that evidence based/best practices are needed to both prepare and motivate students to enter STEM fields; thus, a need exists to identify and modify K-12 and postsecondary education curriculum.

One means of attempting to prevent this crisis of insufficient numbers of minorities in STEM fields is the reform of all facets of STEM education from early childhood to that of graduate education; thereby initiating a renaissance in STEM education (National Science Board, 2007). Minority students possessing the potential to be successful in STEM careers often fail to realize this potential while in high school, or while in college decide to leave the STEM track due to inadequate motivation (Hossain & Robinson, 2012). As a result, difficulty exists for U. S. high schools to get large numbers of students to choose to enroll in STEM related academics (Hossain & Robinson, 2012). If low enrollment and interest in STEM academia persists, then high school courses linked to selection of STEM majors in college and STEM careers will be at serious risk (Hossain & Robinson, 2012). Changes in education and curriculum, according to Jackson (2013), may lead to an increase in motivation, and may assist with increasing the enrollment and retention of African-Americans.

Student motivation is an essential affective outcome necessary for the improvement of science classrooms (Velayutham & Aldridge, 2013). In an effort to stimulate and heighten student learning, familiarity about students' perceptions of the learning environment and how it affects students' learning is of great importance (Velayutham & Aldridge, 2013). A great challenge observed by instructors is the ability to provide a classroom environment that promotes not only motivation, but also positive learning outcomes (Velayutham & Aldridge, 2013). The National Center on Education and Economy (NCEE) (2006) suggested U.S. STEM education is outdated, and does not support the skills needed to be successful in current STEM career fields. As a result NCEE (2006) strongly recommended the need for teachers to ensure integration of technology-based instruction in the classroom. Carlisle (2010) suggested that students enrolled in a flipped classroom appeared to be more motivated to learn and wanted to take more accountability for their learning. The premise of the research study was to determine if altering the educational strategy in a high school science course through the implementation of a flipped classroom increased motivation to enter in a science field, while also assessing how academic achievement is impacted.

This chapter focused on STEM education, STEM education's effect on motivation and academic achievement of minorities, and how the flipped classroom may be a viable component to increase motivation and academic achievement for underrepresented minorities (URMs). A brief synopsis of the problem and purpose of the study was given along with the significance of conducting the research. The independent, dependent, and control variables of the study that examined, coupled with key terms and definitions. The chapter concluded with the questions and hypotheses for the research study, the statistical design, and summarization of the analytical procedure used for the study.

Background

STEM Education

Rice, Barth, Guadagno, Smith, and McCallum (2013) suggested that improving STEM education will determine if the U.S. remains a leader among the nations. One problem that currently exists is the inability of American students, more specifically underrepresented minorities (URMs), to persist in STEM fields as a result of inadequate academic preparation (Rice et al., 2013). Another problem is also the lack of motivation to enroll in STEM courses or select STEM careers (Rice et al., 2013). Social cognitive models assessing academic and career outcomes have accentuated concepts such as attitude, interest, motivation, and self-efficacy as being primary components that affect students' pursuit of STEM courses and careers (Rice et al., 2013). A plausible path for increasing students' interest or motivation is through the implementation of an integrative approach to science content delivery with technology (Becker & Park, 2011). Becker and Park (2011) suggested integrative approaches have the ability to provide students with a way of learning content that will improve learning and interest. Integrative approaches connects different disciplines by cross cutting subject matter, and finding unifying concepts. For example, a science teacher can incorporate the skills used in mathematics and language arts classes into the comprehension of a science subject. This in turn could help with enhancing student interest and increase positive attitudes toward STEM fields, and assist with increasing the motivation toward a future in a STEM career. By implementing integrative approaches there is a possibility for gradual improvement of academic achievement by students while simultaneously improving students' interest (Becker & Park, 2011).

Educators have made efforts to exercise integrative approaches in STEM courses using various methods. Previous studies have looked at other interventions and modifications as techniques for increasing interest or achievement (Bryan, Glynn, & Kittleson, 2011; Jewell, 2011; Radenburg, 2013). Bryan et al (2011) examined what motivates adolescents (14-16 year olds) to learn science in introductory science courses, and found that social modeling and collaborative learning activities promoted students' motivation and achievement in science learning, and interest in science careers. Jewell (2011) studied the effects of the implementation of a NXT robotics curriculum on high school students' science attitudes according to grade, gender, and ethnicity. Jewell (2011) examined the attitude of students with science inquiry, enjoyment of science, and career interest. The study showed no significant difference by gender, grade, or ethnicity in science inquiry (Jewell, 2011). However, there was a significant difference among ethnicity and enjoyment of science when examining different grade levels. In fact, greater differences occurred when comparing seniors to freshman and seniors to sophomores. It appeared that upperclassmen and lowerclassmen have significant differences in enjoyment in science. Significant difference was found in career interest among ethnicity, and among grade levels when comparing grades nine and 11 and nine and 12, respectively (Jewell, 2011). The study found no significant difference observed among gender (Jewell, 2011). Rabenburg (2013) looked at predictors for middle school girls' confidence and motivation in science. The specific predictors studied by the researcher were teacher influences, parental encouragement, peer influences, and self-efficacy to predict confidence (Rabenburg, 2013). The results indicated parental encouragement was not a significant predictor, but both peer and teacher influences were significant predictors for confidence and interest in math and science. However, there is minimal empirical data that examines how the implementation of the flipped classroom could benefit students' motivation and academic achievement.

To date, two studies have been found that examined the flipped classroom and STEM education. Glynn (2013) looked at the effects of the flipped classroom on achievement and student attitudes in a secondary chemistry class, and Talley and Scherer (2013) examined pre- and post-implementation of the flipped classroom on students' academic achievement. Glynn (2013) conducted his study in an upper middle class suburban area of Illinois— where the student population is White and Korean, and the school culture is strong with high achieving students. The results of the study showed the flipped classroom did not have an impact on the overall achievement of students, and there was marginal improvement in positive attitudes toward the course (Glynn, 2013). Although there was no positive response to introducing new content, there was an increase in positive attitude toward using the flipped classroom (Glynn, 2013). An increase in positive attitude was observed during block scheduling, 90 minute classes meet alternating days, where each student had an internet capable device (Glynn, 2013); and the flipped class was found more suitable for a student who takes more of an initiative with their learning (Glynn, 2013).

Talley and Scherer (2013) looked at increasing academic achievement of students by implementing the enhanced flipped classroom in a “flipped” STEM course. The authors conducted the study in the undergraduate psychology class at a mid-Atlantic Historically Black College and University (HBCU) where the introduction of new content was given to students using online videos e-books, and other online resources. At the end of the study higher academic scores were observed on content exams, and as such the use of the flipped classroom indicates using effective learning techniques in STEM courses may be significant in increasing retention of African-American in STEM disciplines (Talley & Scherer, 2013). Despite the previous quantitative studies examining the effects of the flipped classroom in a high school and post-secondary STEM course, no empirical data is available that looks at the flipped class environment with African-American students in an urban setting; therefore, the current study examined how the flipped classroom impacts African-American urban high school students’ motivation and academic achievement in a science course.

The U.S. Department of Education (2007) believes that in order to circumvent the diminishing number of STEM applicants in the labor force that one goal for STEM education for grades K-12 is to ensure all students are adequately prepared with the skills needed to be successful in science, technology, engineering, and mathematics. The premise of this goal is to have more students graduating from high school entering into postsecondary institutions equipped with not only the capability, but also the motivation, needed to become STEM professionals, educators, and leaders (U.S. Department of Education, 2007). Research shows that technological integrative approaches improve students’ interest and learning in STEM, and prepares students for a more global economy (U.S. Department of Education, 2007). This begins with ensuring science students are participating in quality and engaging science courses.

STEM education among minorities. The researcher would be negligent to not report research on underrepresented populations when discussing the STEM fields. It is important that research studies take into account minorities and other underrepresented populations. In recent years, closing the gap that exists between gender and URMs, namely African-Americans, in STEM related career fields has been a priority among policy makers (Beede et al., 2011; Wang, 2013). Presumably, the research conducted has focused on the participation of African-Americans in the STEM workforce, and increasing the number of African-Americans majoring in the STEM discipline (Beede et al., 2011; Wang, 2013). Studies have found that the choice of classes selected during both high school and college had a significant contribution as to the differences in incomes earned during the highest point of African-Americans' careers (Machin & 2003; Wang, 2013).

Bonous-Hammarth (2009) remarked that minority students who persisted and were successful in a STEM field exhibited a number of traits including active engagement in courses, but the most important trait was strong academic performance. Some evidence demonstrated how the role high school courses taken by minority students can influence their choice of college major (Wang, 2013). Results from a study by Wang (2013) showed that high school courses taken did have an influence on African-Americans in the choice of science and math majors when entering college.

For more than ten years, more emphasis has been placed on integrating educational technology into the classrooms as a means of motivating students with learning concepts that can be used to solve real world activities (Moore & Chung, 2015). Moore and Chung (2015) suggested integrating technology in the classroom may motivate students to learn course content by increasing interest in core subject classes. The flipped classroom may be the method to develop an educational environment that promotes discovery, problem-based, and student-centered learning (Moore & Chung, 2015).

The Flipped Classroom

With the amount of time spent in the classroom it is not surprising that what transpires within the walls of the classroom are likely to have a profound impact on academic and behavioral outcomes (Velayutham & Aldridge, 2013). Learning environment factors that influence students' learning is important to not only instructors, but educational researchers as well (Velayutham & Aldridge, 2013). As previously noted, according to Velayutham and Aldridge (2013), a positive learning environment is said to be a prominent factor in promoting students' motivation to learn.

Lecturing has been thought to convey a vast amount of information to numbers of students in a seemingly efficient manner (Steinmatz, 2013). Providing students with information was the ideal first step in preparation of students being successful in a respective field or discipline. Lecturing is viewed as a traditional teaching style. In addition, lecturing is teacher-centered where students are passive learners receiving the teachers' knowledge and wisdom (Ahmed, 2013). In this setting, teachers are the sole decision makers of what, how, and when the curriculum will be taught, and the types of assessments to be administered. Dupin-Bryant (2004) defined teacher-centered as "a style of instruction that is formal, controlled, and autocratic in which the instructor directs how, what, and when students learn" (p.42). Conversely, learner-centered is defined as a "style of instruction that is responsive, collaborative, problem-centered, and democratic in which both students and the instructor decide how, what, and when learning occurs" (Dupin-Bryant, 2004, p.42). In a learner-centered class setting students are more actively engaged in the learning process. This style of teaching allows for focus to be on how students learn as opposed to the how the teacher teaches.

A learner-centered instructional approach is a mutually beneficial strategy that can be implemented with minimal resistance by students and educators, allows students to become more engaged in the class and motivated to learn (Dupin-Bryant, 2004). A viable learner-centered strategy that may be used instead of the traditional teacher-centered instruction is the flipped classroom. According to Mason, Shuman and Cook (2013), the flipped classroom is defined as the dissemination of course content outside the classroom using traditional methods and new technological formats. Through this instructional practice that students are now becoming more responsible for their learning by the classroom transforming from teacher-centered to student-centered.

The flipped classroom is having a resounding effect on the act of lecturing by teachers as a method of integrating technology into the class (Mason et al., 2013). There is minimal room allotted for lecture in flipped classrooms due to the utilization of videos, short descriptive or illustrative notes, and readings are assigned prior to class. Thereby, instructional time left in class can be used for problem solving, application and engagement in the material. Although pure empirical evidence is still being gathered about the flipped classroom, there is not concrete evidence indicating why the flipped classroom is successful (Hamdan, McKnight, McKnight, & Arfstrom, 2013; Morgan, 2014). Preliminary nonscientific research does suggest that there are benefits within the flipped classroom. In a survey, 80% of 453 flipped classroom teachers stated students' attitudes and behaviors improved; and 67% stated there was an increase in standardized test scores (Goodwin & Kirstein, 2013). Another benefit of using the flipped classroom model is the teacher having the capability of moving the class forward despite absences by either the teacher or student(s) (Roehl, Reddy, & Shannon, 2013). This is beneficial for students with high absenteeism rates by allowing them to stay on track despite not being in direct contact with the instructor. The implementation of this strategy allows students' misconceptions to be addressed prior to the issues emerging on an exam. Berrett (2012) stated that flipping is frequently discussed in STEM sessions at teaching and learning conferences, and there is a benefit of implementation with respect to STEM courses. The instructional methods traditionally used to teach STEM disciplines, the long tradition of dissemination of content using informative lecture methods, makes the courses ideal for change by initiating the flipped model concept (Berrett, 2012).

As a result of the limited data currently represented on the flipped classroom a need exists for further research to be conducted. In response to these initial statistics it would be most beneficial to initiate more significant empirical research about the flipped classroom in the areas of academic achievement and motivation to determine whether it is a valuable instructional strategy needing to be implemented in all classrooms. As educators, a charge is given to prepare students to be successful in the real world, and being able to find a resolution to the real world problems (Steinmatz, 2013), for students the remedy may be the flipped classroom.

The theories that will be the basis of this study are the self-determination theory (SDT) (Deci & Ryan, 1985) and social cognitive theory (SCT) (Bandura, 1986). The SDT was empirically derived to study issues regarding intrinsic and extrinsic motivation and personality. Intrinsic motivation is defined as a natural satisfaction for learning new material (Bryan et al., 2011). Extrinsic motivation, according to Deci and Ryan (2000), is participating in an activity for a specific outcome, or reward. When the SDT is applied to education its primary concern centers on promoting students' interest in learning and confidence in their capacities and attributes (Deci, Vallerand, Pelletier, & Ryan, 1991).

SCT (Bandura, 1986) was originally developed by Bandura in the 1960s as the social learning theory (SLT) (Bandura, 1977), but later became the SCT in 1986 as social interaction and influence and internal and external reinforcement became the focus and emphasis by the theorist. The SCT postulates students need to believe that they have ability to complete tasks in order to be successful in learning (Bandura, 1986). Although SCT can be applied to any environment, when applied to education its focus is on student motivation, learning concepts, and academic achievement (Bandura, 1986; Schunk & Zimmerman, 1998). For this study, the centralized hypothesis based on the self-determination and social cognitive theories indicate that there will be a statistically significant difference in urban high school students' motivation and academic achievement scores based on type of classroom (flipped, traditional). As applied to this study, these theories hold that one would expect the independent variable(s) type of classroom (flipped, traditional) to influence or explain the dependent variable(s) motivation and academic achievement because the flipped classroom has the potential to increase motivation and academic achievement. This could possibly be achieved by allowing for more hands on activities and application of concepts covered in the course. For STEM, increasing the use of hands on activities in the classroom by students may assist with applying content and concepts covered by the instructor. This increase could potentially lead to an increase in engagement, motivation, and academic achievement; and in turn lead to persistence to successfully master and/or complete a STEM course or program.

Problem Statement

In an effort to avoid future deficits in STEM fields, the U.S. needs to support the talent of its population by growing and expanding recruitment and retention of persons who are underrepresented in STEM fields—URMs (Tsui, 2007; Strayhorn, 2015). Strayhorn (2015) stated expanding URMs involvement in STEM fields is a priority of the U.S. Despite an increasing global need to create capabilities in STEM, many, who are presumed to be gifted in these respective areas during high school, unfortunately, choose not to select a STEM college major (Museus et al., 2011). A factor that limits success in undergraduate STEM courses is the inadequate preparation obtained during students' matriculation through high school (Museus et al., 2011). Inadequate preparation has been associated with the lack of rigor in the curriculum, the time required for study in STEM courses, and inability for students to be able to successfully apply the concepts taught in the STEM courses inside and outside the confinements of the classroom (Museus et al., 2011; Bryan et al., 2011), and motivation, or interest, in STEM courses, college majors, and/or careers (Hossain & Robinson, 2012; Strayhorn, 2015; Museus et al., 2011). Despite the information that has been disseminated thus far through research studies, theorists and researchers agree that more empirical research is needed to further substantiate the descriptive results obtained from previous studies. Talley and Sherer (2013) suggest that best practices or evidence-based practices may be needed to inform K-12 STEM curriculum. An evidence-based strategy used in previous studies that at times has produced positive results, but still needs to be furthered investigated for more conclusive data, is the flipped classroom (Talley & Sherer, 2013).

The U.S. has a deficit pertaining to individuals currently in STEM fields. While looking at the overall low percentage of people currently in STEM fields, representation by URMs—

African Americans and women (Chang, Sharkness, Hurtado, & Newman, 2014; Tsui, 2007)—is much lower in comparison to their racial, ethnic, and gender counterparts (Beede et al., 2011). In this regard, a need to determine the reason why individuals, specifically URMs, are not entering into STEM fields is imminent. Research studies have shown that one of the factors hindering URMs from entering STEM fields is motivation (Hossain & Robinson, 2012; Bryan et al., 2011), and the effect motivation has on academic achievement in STEM courses (Strayhorn, 2015; Museus et al., 2011; Bryan et al., 2011). In effort to correct this issue educational reform should be considered for K-12 curriculum to include more evidence-based learning. One reported evidence-based learning strategy that has reports of improvement of students' motivation and academic achievement in the classroom is the flipped classroom (Talley & Sherer, 2013; Missildine, Fountain, Summers & Gosselin, 2013). Despite positive reports on academic achievement and motivation in higher education, there is still minimal data showing how the flipped classroom impacts science academic achievement and science motivation with URMs in secondary urban settings. As a result, a gap exists in the literature with determining the effects of the flipped class model on science motivation and science academic achievement, and with URMs. Therefore, this study examined the effects of the flipped classroom on motivation and academic achievement of urban high school students in a science course as compared to the motivation and academic achievement of urban high school students in a science course in a traditional classroom setting.

Purpose Statement

The purpose of this quasi-experimental pre/posttest non-equivalent control group study was to examine the effect of the flipped classroom on urban high school students' motivation and academic achievement in a science course at North Star High School. The independent variable, type of classroom, was generally defined as a classroom where the dissemination of course content outside the classroom using traditional methods and new technological formats (Mason et al., 2013). The dependent variables for this study were student motivation and academic achievement. The dependent variable, student motivation, was generally defined as a student's internal desire to learn and be successful in science (Glynn, Brickman, Armstrong, & Taasoobshirazi, 2011) and was measured by the Science Motivation Questionnaire II (SMQ-II) (Glynn et al., 2011). The dependent variable, academic achievement was defined as the level of mastery, as measured by numeric grade, attained in a high school science course according to the Georgia Performance Standards for Human Anatomy and Physiology (Georgia Department of Education, 2006). The instrument used to measure academic achievement was the Human Anatomy and Physiology Endocrine System Unit Test developed by Pearson (2015).

Significance of the Study

A gap in the literature still signifies a need for quantitative data due to most data being qualitative, and in the form of opinion papers (Becker & Park, 2011). The results from this study may provide additional quantitative data to current studies in order to substantiate necessity of flipping science classrooms from traditional instructional strategies to increase minority students' motivation and academic achievement. The flipped classroom is a topic of discussion among all stakeholders, and may be the catalyst needed to change aspects of classroom instruction and increase achievement of students (Berrett, 2012). The study could also possibly identify the impact of an evidence-based learning strategy in determining if an increase in academic achievement and motivation is definitively observed as a result of implementation of a new technological instructional component. The study could lead to determining not only if an increase in academic achievement and motivation is observed, but also possible implications of how the flipped classrooms utilization in classes could be beneficial to all students in grades K-12. More importantly, the study's data could also be used theoretically to show that by increasing the motivation and academic achievement of students that was also an increase in the number of students selecting STEM majors or desiring to enter a STEM field (Weaver et al., 2014; Bryan et al., 2011).

Research Questions

The research questions for the study were:

RQ1: Is there a statistically significant difference in urban high school students' motivation scores, as measured by the Science Motivation Questionnaire II, when participating in the flipped classroom as compared to students who participate in the traditional classroom?

RQ 2: Is there a statistically significant difference in urban high school students' science achievement scores, as measured by the human anatomy and physiology endocrine system unit test when participating in the flipped classroom as compared to students who participate in the traditional classroom?

Definitions

1. *Academic achievement* - level of mastery accomplished on a specific goal (Steinmayr, MeiBner, Weidinger, & Wirthwein, 2015).
2. *Blended learning* - an integrated educational program where students learn subject content both in a physical class setting, and using online resources (Clayton Christensen Institute for Disruptive Innovation, 2012).
3. *Edmodo™* - a free online learning community used to help teachers and students collaborate with one another (Edmodo, 2014).
4. *Extrinsic motivation* - participation in an activity for a specific outcome, or reward

(Deci & Ryan, 2000).

5. *Flipped classroom* - defined as the dissemination of course content outside the classroom using traditional methods and new technological formats (Mason et al., 2013).
6. *Gender* - the biological and physiological characteristics that define men and women (World Health Organization, 2014).
7. *Interest* - a personality characteristic or motivational disposition; preference to participate in a certain topic (Krapp, 1999); a unique motivational variable (Hidi, 2006)
8. *Intrinsic motivation* - a natural satisfaction for learning (Bryan et al., 2011)
9. *Motivation* - internal desire to learn and be successful in science (Glynn et al., 2011).
10. *STEM* - science, technology, engineering, and mathematics (Schachter, 2011).
11. *Traditional classroom* - lecture is used by the teacher for content delivery through face-to-face interaction (Clark, 2014).

Research Summary

This study was a quantitative study as opposed to a qualitative study due to examining and quantifying the differences between the variables. The research design was quasi-experimental, pre-test-posttest non-equivalent control group. The quasi-experimental design was appropriate due to manipulation of the independent variable, type of classroom, and the usage of a control group, as well as randomization of the student sample population not being feasible (Gall, Gall, & Borg, 2007). In order to increase internal validity, a pretest and posttest was used with both the experimental and control groups. Participants were assigned to pre-existing classes, and the classes were assigned to either the control group or the experimental group.

Each group received parallel content material during daily class instruction. However, the experimental group completed lectures, view videos and presentations, completed activities, and some formative assessments using the Edmodo™ website outside of the classroom and periodically during the instructional period within the brick and mortar classroom. The control group was exposed to a traditional class setting where the teacher delivered lectures, activities, assessments, and laboratory investigations within the confinement of the brick and mortar classroom. A detailed instructional agenda for both groups for the length of the study can be found in the appendices (Appendix E). The Science Motivation Questionnaire II (Glynn et al., 2011) and Human Anatomy and Physiology Unit Test (Pearson, 2015) was administered to student participants before and after treatment, and then the results were statistically analyzed and reported. To test the null hypotheses, two separate one-way analysis of covariance (ANCOVA) statistical analyses was employed.

CHAPTER TWO: LITERATURE REVIEW

Overview

Langdon et al. (2011), economists for the U.S. Department of Commerce Economics and Statistics Administration, argued that STEM workers direct the nation's advancement and competitiveness by creating new ideas, companies, and industries. Nevertheless, there is a serious concern over the availability of qualified STEM employees entering into STEM careers. It is often reiterated that unless an increase in the number of individuals entering the field of STEM occurs the U.S. will encounter shortages in experimentation, innovation, and technological fields (Schneider, Judy, & Mazuca, 2012). In 2010, Chairman Richard Stephens of The Boeing Company and Chairman Aerospace Industries stated before the Committee of House and Science Technology that specific actions were required in order to ensure the U.S. was adequately equipped with sufficient numbers of scientists and engineers in order to meet the needs of the future (Stephens, 2010). One of the most pertinent needs mentioned, was motivating students to pursue STEM related careers. Individuals working in STEM fields are vital in sustaining growth and stability of the economy of the U.S. (Langdon et al., 2011). During a ten year period spanning from 2000 to 2010, the U.S. saw a 7.9% increase in STEM occupations as compared to 2.6% in non-STEM occupations (Langdon et al., 2011). According to the U. S. Department of Commerce, from 2008-2018 there is a projected growth of 17% in STEM employment as compared to 9.8% for non-STEM employment (Langdon et al., 2011).

Another concern is the participation of African-Americans in STEM careers continues to trail behind Caucasians and Asians (Schneider et al., 2012). The U.S. Census Bureau's 2009 American Community Survey (Beede et al., 2011) indicated the number of people working in STEM jobs, according to ethnicity, was predominantly occupied by non-Hispanic Asians (15%), non-Hispanic Whites and non-Hispanic Others (6% respectively), non-Hispanic Blacks and American Indians or Alaska Natives (3% respectively), and Hispanics (2%). Forecasts imply the percentage of URMs currently in science and engineering needs to increase threefold in order to complement their proportions within the U.S. population (Schneider et al., 2012). There are a number of probable factors that may lend to the decrease in STEM numbers. Studies found that women and URMs (Hill, Corbett, & Rose, 2010; Griffith, 2010) along with students from low socioeconomic backgrounds leave STEM fields at higher rates than their counterparts (Kokkelenberg & Sinha, 2010). As well as persons leaving STEM fields has shown to occur more frequently with weaker academic backgrounds in math and science (Shaw & Barbuti, 2010). Lastly, evidence showed a relationship between the decrease in STEM fields, and factors such as motivation, confidence, and a person's belief in one's ability to learn respective STEM subjects (Chen, 2013). A means of achieving this may lie within the secondary educational system. Jewell (2011) states that The U.S. Department of Education reports that, of approximately four million students enrolled yearly in pre-school, around 20% remain interested in STEM subjects by the time of entering eighth grade, 16% are still interested by 12th grade, 9% major in an area of STEM in college, and only 4.5% graduate with a STEM-related degree. The data again reiterates plausible linkage between students' motivation, and decisions to enroll in STEM fields with the decrease in students' attitudes and interests in science. This makes it more difficult to decide to enroll in a science course, select a STEM major, or enter a STEM career (Weaver et al., 2014).

Although the focus of this research study will be on motivation, students' attitudes are being briefly examined as attitude and motivation are thought to be interdependent of one another (Chauhan, 2014). Gardner, Lalonde, and Moorcroft (1985) stated attitude is a component of motivation, and thus motivation is the favorable attitude to achieve learning. Studies conducted by Murphy and Beggs (2003) and Pell and Jarvis (2001) indicated a negative correlation between students' attitudes and age from as early as kindergarten. Historically, evidence was presented showing the trend of adolescents' decreasing interest in science (Speering & Rennie, 1996); Murphy & Beggs, 2003; Pell & Jarvis, 2001). Speering and Rennie (1996) conducted a study in Western Australia where observance of a decrease in science interest was made as students transitioned from elementary to secondary schools. Speering and Rennie (1996) also showed decisions to pursue further science courses and/or choosing a career in the science field were made at critical points in time. These critical points in time were during students' adolescent years while transitioning from elementary to middle school (Speering & Rennie, 1996). However, Eccles and Wigfield (1992) conducted a study where analysis of various achievement task values was completed, and results indicated a decline in students' attitudes occurred during adolescent years. Christidou (2011) stated students lose interest in science, and as a possible future aspiration, as they move from elementary to middle school. Conversely, Lai's (2011) motivation research report showed that motivation increased with age as students become more exposed to experiences in life. Researchers suggest encouraging motivation in children is vital because it aides with predicting motivation later in life (Lai, 2011).

There are studies that support the age of 14 being the most important time for a student to make a decision about pursuing more science studies (Tytler, 2014; Tai, Qi Liu, Maltese, & Fan, 2006). The Royal Society (2006) examined a survey completed by science, engineering, and technology practitioners (N = 1141) and found adolescents' decision for pursuing a science career was made by or before age 14. The study also showed 28% of those completing the survey started thinking about a STEM career before age 11, and 35% between ages 12 and 14

(Royal Society, 2006). Maltese and Tai (2010) interviewed scientists and graduate students regarding experiences that engaged them in science. Of the participants (N = 116) surveyed, 65% stated an interest in science before entering middle school, and 30% during middle school and high school (Maltese & Tai, 2010). The question then becomes what is a possible means for increasing and sustaining student interest in science after entering secondary education?

During this time of science educational reform, an interest was reintroduced into the features of the learning environment contributing to student learning and interest in science (Nolen, 2003; Vedder-Weiss & Fortus, 2011). Nolen (2003) examined the relationship between high school students' (N = 377) perceptions of their science learning environments, and their motivation, learning strategies, and achievement. Results indicated direct correlation with the shared perceptions of the classroom climate and students' science achievement and satisfaction with science learning (Nolen, 2003). Evidence indicated classrooms where teachers required independent thinking resulted in students having deeper levels of comprehension higher achievement, and better satisfaction with science learning (Nolen, 2003). Vedder-Weiss and Fortus' (2011) study conducted in Israel examined fifth through eighth grade students attending traditional and democratic schools. While conducting research the authors found there is a relationship between the decrease in students' attitude and motivation in science learning, and changes in classroom environment (Vedder-Weiss & Fortus, 2011). It was also suggested the continued decrease in students' motivation may be associated with the way teachers teach science (Vedder-Weiss & Fortus, 2011). With the idea classroom learning environments have a role in students' science motivation and learning it is thought perhaps by altering the traditional classroom into a flipped classroom may be beneficial to increasing both students' motivation and achievement in the secondary science classroom. Carlisle (2010) noted instructors stated students appeared to be more motivated possibly as a result of implementation of the flipped classroom. The implementation of the flipped classroom not only showed possible indications for increasing student motivation, but students were now also required to take ownership of their learning while also increasing higher order thinking skills (Carlisle, 2010).

Increasing access to quality STEM education has the ability to improve the quality of the U.S. labor pool by increasing economic growth and keeping the U.S. competitive (Casey, 2012). A major concern is lack of persistence in STEM participation coupled with achievement gaps across specific demographics—women, blacks, and Hispanics. Blacks account for 6% of STEM workers in the U. S.; and during the time period of 2000-2009 there was only a 1% increase in the workforce (Casey, 2012). It is presumed if these disparities were addressed and improved, the U.S. would be better suited to fulfill the demand for STEM personnel (Casey, 2012).

The National Center for Education Statistics (NCES) in 2009 (2011) conducted the National Assessment of Educational Progress (NAEP) exam, and found 28% of fourth graders, 37% of eighth graders, and 40% of 12th graders failed to meet the basic standards of science knowledge. The same examination was conducted again by the NCES (2011) at which time data was obtained from eighth grade students from 47 states across the U.S. Results indicated slight increases across a number of respective demographics; 35% of eighth graders participating in the NAEP exam did not meet the basic standards for science, 63% black eighth graders failed to meet the basic standards in comparison to only 20% of whites (NCES, 2011). Results from the study also showed 36% of public schools versus 23% of the private schools did not meet the basic standards for science (NCES, 2011). According to Schneider et al. (2012), high schools may be a place that can aid in closing the gap of low numbers of persons entering STEM fields. As such, this study will focus on the flipped classroom in order to determine whether there is a relationship between the flipped classroom, and increasing science motivation and science academic achievement of African-American students in an urban high school.

This chapter provided an overview pertaining to the current literature pertaining to STEM and the flipped classroom. The urgency of guiding students in STEM fields, students' attitudes, motivation, and interest in STEM courses, science academic achievement gap by gender and racial ethnicities, and the economic impact of STEM will be discussed. Flipped classroom will be discussed with a focus on advantages of implementation inside the classroom, and the relationship between academic achievement and the flipped classroom. The theoretical frameworks, self-determination theory and social cognitive theory, which provide the basis for the foundation of the study, will be discussed, and finally an overview of the gap in the literature that identifies the significance and necessity for the research is given.

Theoretical Framework

Theoretical frameworks of research studies help to formulate the foundation and support for the study by guiding the research, determining variables to be measured, and possible statistical relationships that may exist. For this study, the social cognitive theory (SCT) (Bandura, 1986) and the self-determination theory (SDT) (Deci & Ryan, 1985) was used. The SCT (Bandura, 1986) was used because of the focus of on social interaction and influence, and internal and external reinforcements. The SCTs foundation is based on expectations about learning and behavior (Denler, Wolters, & Benzon, 2014). The SCT was used for this study because is often used to help determine career choice, organizational behavior, and mental and physical health (Denler et al., 2014). The relevance for using the SCT for this study also rested with the knowledge that the theory is used in studies to examine comprehension of classroom motivation, learning and achievement (Denler et al., 2014). The SDT (Deci & Ryan, 1985) was used because of its focus on intrinsic and extrinsic motivation issues in research studies. The SDT looks at the internal and external factors that appear to affect a person's motivation and personality (Self-determination theory, 2016). The SDT observed external factors such as reward systems, grades, or opinions obtained from other individuals; whereas internal factors observed were those such as interest, curiosity, and values (Self-determination theory, 2016). By looking at individual's inherent growth tendencies and psychological needs helped Deci and Ryan (2000) determined the overall perceived needs required for improvement and social development—competence, relatedness, and autonomy. By using both theories, the SCT and SDT, as the basis for this study the researcher looked at the influence of the flipped classroom on students' motivation and academic achievement in their science course.

Social Cognitive Theory

A student having the "ability" to be successful is not the only component necessary to achieve in the academic realm or prosper in the labor workforce. However, students' "belief" that success is attainable is learning is a confounding factor (Bandura, 2006). Bandura developed the SCT that postulated the need for students to believe they have the ability to achieve tasks in order to be successful in learning (Bandura, 1986, 2001, 2006). According to Denler et al. (2014), the SCT integrates five specific concepts: observation, outcome expectations, goal setting, self-efficacy, and self-regulation. Bandura (1986) developed the SCT, a theory that has also served as the foundation for other theoretical frameworks, which describes the reciprocal connections of human learning and motivation (Bandura, 1986, 2001, 2006). Bandura (2006) believed students' learning is viewed as being most effective when students comprehend, monitor, and control their motivation and behavior. This self-regulation by students is presumed to lead to desirable learning outcomes. According to the theory, motivation is the internal state that stimulates, directs, and sustains goal-oriented behavior (Bandura, 2001, 2006). Human learning and motivation involves a series of connections that involve "personal characteristics (e.g. intrinsic motivation, self-efficacy, and self-determination), environmental contexts (e.g. high school), and behavior (e.g. enrolling in advanced science courses)" (Bryan et al., 2011, p. 1050). Since its development, the SCT has been used in a myriad of environments including business, health, and educational industries (Clark, 2014). In the educational field there is a concentration on student academic achievement, student motivation, and learning concepts (Clark, 2014). While other theories of learning and motivation exist that can lend explanation to respective aspects of learning behavior, the inclusiveness of the SCT is the most appropriate for this study.

The SCT was created to show how people obtain values and attitudes and how motivation regulates their functionality (Bandura, 2006). Glynn et al. (2011) stated motivation, as it relates to the SCT is expressed internal arousal of motivation to learn science. Glynn et al. (2011) believed academic achievement is observed in motivated students when engagement in behavior such as asking questions, seeking advice, studying, active participation in classes, laboratory investigations, and study groups is done.

The SCT is a theory that is not constructed on the biological differences of people, but instead society's influence on the forces of socialization (Kim, 2010; Williams & Takaku, 2011). Society influences its behaviors and interests upon individuals in an effort to mold them into society's desired outcome as viewed by three categories—gender, ethnicity, and socioeconomic status—influenced by societal forces (Clark, 2014). Significant differences are often revealed by gender when pertaining to science, technology, engineering, and mathematics as perceived stereotypes are observed by the dominance of males in STEM fields (Hong, Hwang, Wong, Lin,

& Yau, 2012). Ethnicity is strongly influenced, perceived or actual, through persuasion of races to excel; a number of influences are dependent on "family norms, cultural learnings, discrimination, racism, parent education, and social class" (Clark, 2014, p. 41). Socioeconomic status influences are found in the academic realm when looking at the student success (Clark, 2014; Boxer, Goldstein, DeLorenzo, Savoy, & Mercardo, 2011). Boxer et al. (2011) believed economically disadvantaged children are aware of barriers they face in comparison to non-disadvantaged children, and as a result do not make education, or even the pursuit of higher education, a priority.

A student's choice of science or STEM subjects is not solely dependent on one factor, but instead multiple factors that also interact with one another (Tytler, 2014). Fouad, Hackett, Haag, Kantamneni, and Fitzpatrick (2007) made use of a questionnaire based on the SCT that monitored students at various stages of school in order to identify relevant supports and barriers to choosing science. The questionnaire examined interests and aspirations of students in relation to effects of interactions between personal factors and learning experiences on outcome expectations and self-efficacy (Fouad et al., 2007). Results identified barriers as being perceptions of subject difficulty and test anxiety (Fouad et al., 2007). Substantial predictors of choosing to continue with science courses found were interest, self-evaluation of ability, parental expectation and guidance, career guidance, and inspirational instructors (Fouad et al., 2007).

Self-Determination Theory

The SDT (Deci & Ryan, 1985) suggests people have basic psychological needs to feel independent, or self-directed, and in control. Thus, Deci and Ryan (1985) imply students' motivation for learning may be described according to the degree learning will gratify that need. Students' motivation may be a contingency of self-determination ranging from internally to externally (Deci & Ryan, 1985). Intrinsic motivation is referred to as motivation to participate in an activity for the purpose of the pleasure and satisfaction from the accomplishment (Deci & Ryan, 1985). Students are said to be intrinsically motivated when engaged in learning things that are of interest to them (Deci & Ryan, 1985). Conversely, extrinsic motivation is motivation to participate in an activity as a means to an end; the more the activity is forced on the student the more extrinsic motivation ensues (Deci et al., 1991).

Ryan, Kuhl, and Deci (1997) stated the SDT is a method for human motivation and personality that uses conventional empirical techniques to show the importance of inner personality development and behavioral self-regulation. Therefore, the focus of the SDT is investigation of the natural growth tendencies and distinctive psychological needs of individuals; the premise for their self-motivation, and the conditions that promote those positive processes (Ryan & Deci, 2000).

Over time, the SDT (Deci & Ryan, 1985) has evolved through the use of experimental studies which resulted in the emergence of different motivational phenomena. Figure 1 shows the five sub-theories that of the SDT (Deci & Ryan, 1985), and the correlation of the motivational phenomena associated with each. The basic needs theory (BNT) (Reeve, 2012) puts emphasis on the psychological needs as part of the inner motivational resources, and its relationship with students' motivation, engagement, functioning, and well-being. Organismic integration theory (OIT) (Reeve, 2012) puts attention on internalization, and why students begin socially relevant behaviors. This sub-theory is a direct extension of the extrinsic motivation component of the SDT (Ryan & Deci, 1985) by expounding on the success versus unsuccessfulness of students' academic socialization (Reeve, 2012). Goal contents theory (GCT) (Reeve, 2012) centers on the "what" of motivation, and assists with determining the difference between intrinsic and extrinsic goals. Cognitive evaluation theory (CET) (Reeve, 2012) looks at how intrinsic motivational processes are affected by external events such as rewards and feedback. It is presumed that at times the external events may interfere with the psychological needs and perceptions of competence of students (Reeve, 2012). Lastly, causality orientations theory (COT) (Reeve, 2012) describes the differences in how students motivate themselves. Some students motivate themselves for more self-driven purposes, and other students tend to trust more so on controlled environmental guides.

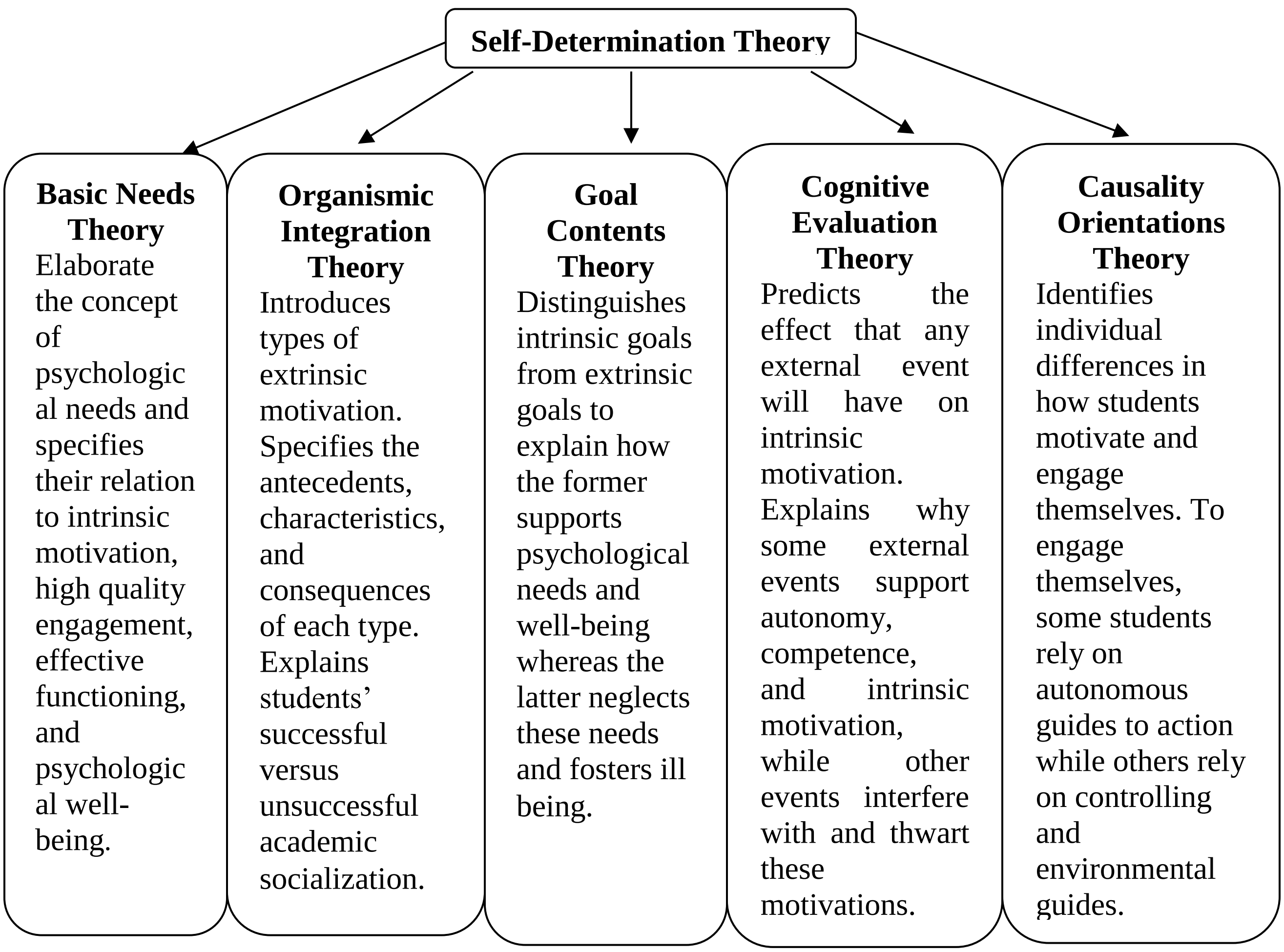


Figure 1. Five mini theories of self-determination theory. Five mini theories of SDT and the motivational phenomena each were developed to explain (Reeve, 2012, p. 153).

in classroom applications. Authors Deci and Ryan (2000) presumed that despite a student's age, gender, socioeconomic status, nationality, or cultural background, each student would have inherent growth tendencies such as intrinsic motivation. The inherent growth tendencies would then lead to creation of a motivational foundation for excellent engagement in the classroom and positive school workings (Deci & Ryan, 2000). The difference between other motivation theories and SDT is the emphasis the SDT places on the instructional task of embracing students' inner motivational resources (Deci & Ryan, 2000). The stimulation of students' inner motivational resources is perceived as the primary step in creating relevant and critical engagement in the class (Reeve, 2012). More specifically, the SDT recognizes inner motivational resources students hold, and then suggests recommendations to educators that can involve, cultivate, and bolster the resources during the instruction (Niemiec & Ryan, 2009). This will presumably assist with increasing higher quality student engagement (Niemiec & Ryan, 2009).

Related Literature

STEM

STEM careers and education minorities. In order to effectively compete in the global marketplace reports by the Committee on Equal Opportunities in Science and Engineering (CEOSE) (2013) reiterate a need for the U.S. to increase the number of STEM educated workers. The U.S. is known for producing top scientists and engineers who are able to compete on a global level, and have the capability to create advancements in science and technology (Casey, 2012). These advancements have changed the way U.S. citizens live, work, and play, and achieve the economic benefits of Americans with the needed STEM skills (Casey, 2012).

Innovations in technology further enhances the competitiveness of U.S. industries and support quality STEM jobs (Casey, 2012).

Vilorio (2014), an economist with the Office of Occupational Statistics and Employment Projections, analyzed data from the U.S. Bureau of Labor Stastistics (BLS) that supports the idea that the future of the economy is in STEM. The U.S. BLS predicted from 2012 to 2022, employment in STEM occupations will increase to more than nine million (Vilorio, 2014). This is a projection of approximately 13% for STEM employment in comparison to 11% growth projections for all occupations (Vilorio, 2014). For more than ten years, numerous governmental entities such as the National Science Foundation (NSF) (2015), and the National Academy of Engineering and Institute of Medicine (2007), have sustained the U.S. productivity and strength will experience a decline if significant change is not conducted . A possible remedy would be to increase the number of persons entering into the STEM pipeline by selecting a STEM major, and then entering the STEM workforce (Chang et al., 2014).

One of the most important recommended actions is concentrating on racial disparities toward obtaining post-secondary degrees in STEM fields (Committee of Equal Opportunities in Science and Engineering, 2013). The U.S. must enhance its reform efforts toward educating URMs who are not adequately utilized for the STEM industry in order to keep the tradition of STEM leadership, and aid in resolving the issue of competitiveness (Committee on Equal Opportunities in Science and Engineering, 2013). According to Beede et al. (2011), the U.S. Department of Commerce, Economics and Statistics Administration found non-Hispanic blacks and Hispanics are less likely to enter a STEM field, and therefore, continue to be consistently underrepresented in STEM jobs over the past ten years. Thereby, there is a need for the U.S. to continue to produce a workforce that will be able to continue to provide STEM leadership, and enable the U.S. to remain ahead in its global competitiveness. The National Science Foundation (2014) communicated three primary goals pertaining to K-12 STEM education:

- "Expand the number of students who ultimately pursue advanced degrees and careers in STEM fields and broaden the participation of women and minorities in those fields;
- Expand the STEM-capable workforce and broaden the participation of women and minorities in that workforce; and
- Increase science literacy for all students, including those who do not pursue STEM-related careers or additional study in the STEM disciplines." (p. 9)

Although there was an increase over the past 50 years in the number of women and African-Americans earning degrees in a STEM field and the numbers have improved slightly for those entering science and engineering employment, a shortage still exists between the supply and demand in STEM careers (Committee on Equal Opportunities in Science and Engineering, 2013). Females and African-Americans have shown gains, but continue to remain significantly behind in all areas of science and engineering (Committee on Equal Opportunities in Science and Engineering, 2013). Women not only are inadequately represented in various STEM fields, but also according to the National Science Foundation (2013), earned less than 30% of the degrees issued in science and engineering despite receiving approximately 57% of all undergraduate degrees (see Figure 2). Even more alarming is less than 15% of ethnic minority students received undergraduate degrees in math, engineering, or science (National Science Foundation, National Center for Science and Engineering Statistics, 2013). African-Americans and African-American women respectively earned 8.8% and 5.6% of undergraduate degrees issued in science and engineering out of the 9.9% total undergraduate degrees issued to African-Americans (see

Figure 3) (National Science Foundation, National Center for Science and Engineering Statistics, 2013).

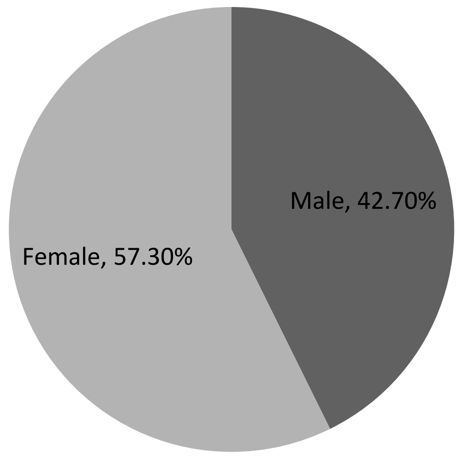


Figure 2. Total number of undergraduate degrees presented in 2012 for both science and engineering and non-science and engineering students according to gender.

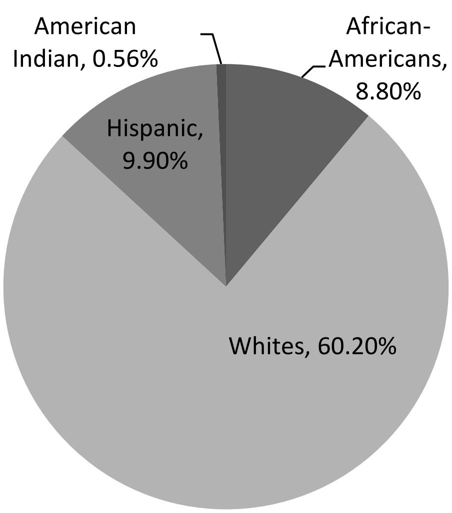


Figure 3. Total number of undergraduate degrees presented in 2012 in science and engineering according to ethnicity.

The National Science Foundation (2013) showed women earned 9.7% of master's degrees in science and engineering of the total number of master's degrees issued with 11.3% being awarded to African-Americans in science and engineering. Of the total doctoral degrees issued, 57% were in science and engineering, 23.4% were women in science and engineering, and 1.8% was African-Americans (National Science Foundation, National Center for Science and Engineering Statistics, 2013). The National Association of Science suggested that in order to maintain equal leverage in preparing for a more diverse workforce a short term goal needs to be made to increase the number of underrepresented undergraduate minorities getting STEM degrees by at least two-folds (Chang et al., 2014). The Higher Education Research Institute (2010) showed 33% White, 42% Asian, 22.1% Latino, 18.4% Black, and 18.8% Native Americans completed undergraduate degrees within five years.

Prior research studies indicated variables contributing to the retention of students majoring in STEM fields in four year institutions (Museus et al., 2011; Kokkelenberg & Sinha, 2010; Chen, 2013; Strayhorn, 2015). A repeated factor that continued to appear was students' academic preparation while in high school (Chang et al., 2014; Elliott, Strenta, Adair, Matier, & Scott, 1996). Elliott et al. (1996) found significantly less preparation among African-American students in pre-college sciences during high school. A study conducted by Russell and Atwater (2005) also showed that competency in pre-college math and science courses is relevant to African-American students' level of success through the matriculation of science courses from high school to college.

A number of problems exist within the educational pipeline in the U.S. According to Casey (2012), these problems "…can lead to a shortage of STEM professionals. Without a strong foundation in math and science from elementary and secondary school, students may find themselves unprepared to train for and pursue careers in STEM fields" (p.8). Strayhorn (2015) identified academic preparation as an influencing factor for African Americans entering college and STEM majors. The researcher found a connection between previous academic achievement and the success in later science and engineering programs (Strayhorn, 2015).

Strayhorn (2015) noted URMs may decide to switch to non-STEM majors for reasons including lack of sufficient preparation for college-level science and math courses. This could be due to URMs not being exposed to advanced, or more rigorous, science and math courses while in high school (Strayhorn, 2015). These academic deficiencies have the ability to have lasting effects on persons desiring to study STEM due to these respective math and science subjects being the basic curriculum of STEM.

Foltz et al. (2014) conducted an exploratory study looking at contributing factors leading to minority graduate students persistence in STEM fields. Foltz et al. (2014) interviewed minority STEM graduate students about factors, people, events, and other variables that allowed for endurance in the STEM field. The results of the study showed most participants stated that a strong high school academic preparation was pertinent to their success in persisting in STEM fields (Foltz et al., 2014). The researchers suggested selection of STEM should be made at an early age, and that to do so the kindergarten through 12th educational system should be prepared to expose and rigorously prepare younger students for respective STEM subjects (Foltz et al., 2014). Authors Chang et al. (2014) and Tsui (2007) found the gap in STEM was more widely observed in racial and ethnic minorities—more specifically African-Americans. Chang et al. (2014) suggested that a contributing factor to STEM retention is students' academic preparation in high school. A strong competence in pre-college mathematics and science courses is important to African-American students' having successful progression through the science pipeline from high school to college (Chang et al., 2014).

The percentage of high school students who articulate interest in a STEM career has dropped significantly leading to less than 2% of U.S. high school graduates receiving STEM degrees (Moakler & Kim, 2014). This results in the dwindling number of STEM graduates with the proficiency and skills needed to stimulate international economic and technological advancement (Moakler & Kim, 2014). The General Accounting Office (GAO) (2005), in response to the decrease in persons receiving STEM degrees, called for the recruitment of U.S. citizens to STEM majors in an attempt to secure human capital for the U.S. labor pool. Not only did the GAO recommend investing in human capital, but that focus should be on U.S. female and minority student recruitment into STEM disciplines (GAO, 2005).

African-Americans have been, and are continuing to be, underrepresented in STEM education and careers. Despite making up approximately 12% of the total U.S. population, African-Americans receive less than 5% of the STEM bachelor and postsecondary degrees (Moakler & Kim, 2014). Barriers by minorities have been identified that often hinder the pursuit of undergraduate degrees (Moakler & Kim, 2014). Some barriers identified were academic performance, interest, motivation, and financial issues (Moakler & Kim, 2014). The absence of interest in STEM careers has a strong affect on academic motivation which in turn leads African-Americans students to exclude STEM disciplines from their course of study**.**

Motivation and interest in STEM. It is essential for educators to comprehend the importance of motivation to the process of learning. Koballa and Glynn (2010) stated motivation directly drives students' behavior. Over time motivation has become relevant across all disciplines ranging from education to management (Keklik & Erdem-Keklik, 2012). Despite this, motivation is not manipulated or assessed as frequently by science educators, although historically research on learning was shaped by motivation theories (Koballa & Glynn, 2010). With response to current national iniatives pertaining to science achievement an increased emphasis on the role of motivation is becoming more imperative (Koballa & Glynn, 2010). Hodges (2004) viewed motivation not only as a factor that promotes learning, but also the result of learning. Science education researchers studied motivation in order to examine why and how students strive when learning science, and the feelings associated with this process (Koballa & Glynn, 2010). Prior motivation studies conducted in the 1980s (Maehr, 1983; Nicholls, 1984) tried to distinguish the goal orientations and motivational processes relationship among students. This was conducted to find what the means of attaining goals, and the motivational process these goals will be accomplished. Studies contended goal orientations can be observed as associated task versus the involved self-image or personality (Maehr, 1983; Nicholls, 1984). Associated tasks refers to persons desiring to demonstrate ability through completion of a task; whereby social or external introspection of self is not needed (Nicholls, 1984). Ego-involved individuals must determine what is to be mastered, and whether this will beneficial to oneself in the end (Nicholls, 1984). Other researchers theorized goal orientations as that of being learning oriented versus performance oriented (Dweck, 1988; Dweck & Elliott, 1984). Learning oriented is viewed as learning toward mastery, and performance oriented is driven moreso by extrinsic factors such as motivated only to perform in comparison to learn for mastery (Dweck, 1988).

Bropy (1987) defined the ‘motivation to learn’ as, finding activities to be meaningful and worthwhile while determining the academic benefit. Motivation to carry out an activity for one’s own purpose is intrinsic motivation, whereas completing an activity as a means to an end is extrinsic motivation (Pintrich & Schunk, 1996). Intrinsic motivation draws on the normal human inclination to pursue interests, and then apply the capabilities (Pintrich & Schunk, 1996).

The extent to which students are intrinsically motivated is attributed to students' self-determination. Self-determination, according to Deci et al. (1991) and Reeve, Hamm, and Nix (2003), stands on the capability to have choices and some facet of control in what and how a task is done. The development of the SDT (Deci, 1996) proposed students need to feel competent and independent, and intrinsically motivated tasks stimulate independence and feelings of competence. It was also noted students who possessed self-determination motivation were more probable to achieve at a higher level (Deci, 1996).

Young students aspiring to become future scientists should find a benefit to being motivated to learn science. However, it is also important to show the value of all students becoming motivated to learn science in an effort to nurture their scientific literacy (Organisation for Economic Cooperation and Development [OECD], 2007). The drive for all students to become motivated to learn science is a focus being supported (Feinstein, 2011; Kelly, 2011; Roberts, 2007). Scientific literacy is recognized as:

- The ability to comprehend scientific knowledge
- Ascertain relevant scientific questions
- Extract evidence based conclusions
- Arrive at decisions pertaining to the affects of human activity on the natural world (Organisation for Economic Cooperation and Development, 2007).

According to Abrams et al. (2014), for more than 20 years scientific literacy for students has been the goal for reforms in science both nationally and internationally. Nevertheless, more recent developments are focused more toward meeting global demands for the STEM workforce by increasing students who are pursing degrees and careers in the STEM field (Abrams et al., 2014). The focus centered on minorities, but instead of focusing on STEM pipeline concerns and attempting to increase the number of qualified minority students interested in STEM careers, academic institutions are left contending with one another for the small number of minority students (Abrams et al., 2014).

A major concern within science education research and policy pertains to students' interest and motivation in science (Organisation for Economic Cooperation and Development, 2008). According to Osborne (2008), students realize the importance of science-related issues, but consequently choose not to engage in science courses at school nor potentially see themselves selecting a career in the field. Maltese (2008) analyzed a large longitudinal study where data was collected over a period of time covering school and college years. The author found intricate results with students choosing whether to remain in or leave STEM subjects. The study showed early perception of the vitality or importance of STEM as a means of predicting a future degree in STEM, scores in a science course, and the importance or usefulness of science and math as a positive means of persisting in the subject(s) (Maltese, 2008).

Cleaves (2005) interviewed high-achieving secondary students (N = 72) in order to look into factors that influence students' science subject choices during year nine and year 11. Cleaves pinpointed negative attributes—irrelevance, boredom, scientists' work, and stereotypical perspectives of scientists—to science. Some students reported that the negative experiences did not steer them away from making a choice to pursue further STEM studies (Cleaves, 2005). Cleaves (2005) determined through an identity framework that students' perceptions of their ability to achieve coupled with their aspirations is the driving force of whether or not to go into STEM.

Sherz and Oren (2006), showed students have negative connotations and misleading perceptions about science related occcupations, and therefore make the decision to choose a career in another field. The negative connotations and misleading perceptions could lend to students lacking motivation to continue to select a career in STEM. Studies conducted on science motivation led science education researchers to determine the emotions behind students striving to learn science (Bryan et al., 2011).

Bryan et al. (2011) conducted research on motivation of 14-16 year old adolescents to learn science in an introductory science course. Using data collected from a questionnaire and interviews the results of the study found students were motivated by relevance of science to their education and career interests (Bryan et al., 2011). Results also indicated students were motivated by participation in hands-on activities and collaboration, and were less motivated by the overwhelming amount of contextual information and teachers who relied primarily on PowerPoint presentations (Bryan et al., 2011). Instead, the students sought to have more autonomy, inquiry based activities, and social interaction within their science classes (Bryan et al., 2011).

Loukomies et al. (2013) observed students' motivation along with the potential to improve motivation through the establishment and maintenance of students' psychological needs and interest. This was attempted through the design of a science education teaching sequence that allowed secondary school students to increase their motivation toward science learning (see Figure 4). A total of 54 eighth and ninth graders from Finland and Greece used the Evaluation of Science Inquiry Activities Questionnaire, an instrument based on the Intrinsic Motivation Inventory (Deci et al., 1994). The Intrinsic Motivation Inventory is a multidimensional instrument used to assess participants' subjective experience (e.g. interest/enjoyment, perceived competence, effort, etc.) (Deci et al., 1994). The results of the study showed no difference in motivation of the sample population after implemention of the designed teaching sequence (Figure 2).

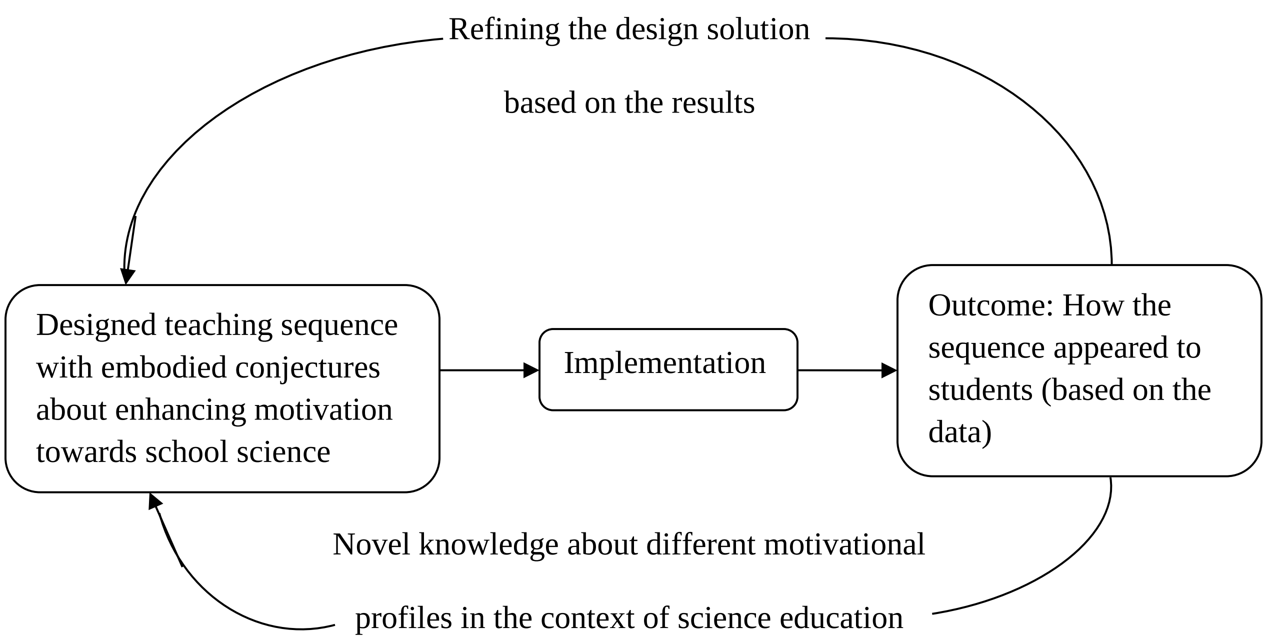


Figure 4. Teaching sequence of science education. Teaching sequence of science education and refining the design based on collected data during implementation. Adapted from "Promoting students' interest and motivation towards science learning: The role of personal needs and motivation orientations," by A. Loukomies et al., 2013, *Research in Science Education, 43*, p. 2518. Adapted with permission.

The study, based on the SDT, found students valued the aspects differently that were supported to increase their motivation (Loukomies et al., 2013). The results showed the importance of science education courses being organized to allow all students at least one reason to be actively engaged in and enjoy the teaching and learning process (Loukomies et al., 2013).

In a longitudinal study by Krogh and Anderson (2012), a group of Danish students were followed through the final years in upper secondary school and university mentorship in order to observe their decisions about potentially staying in the STEM pipeline. Krogh and Anderson

(2012) reasoned that exploration of the numerous variables involving STEM related science education research may help with providing insight as to how students' incorporate science into their personal belief. Traditionally, research focused on relationships between intrinsic variables (i.e. interest, motivation, etc.) and the impact on achievement or behavior (Tytler, 2014); even so, evidence implies socially based variables (i.e. students' experiences, achievement, relationships, etc.) (Cerinsek, Hribar, Goldez, & Dolinsek, 2012).

Various reasons were suggested about the lack of interest in science with the most prominent being the negative positions toward science by students (Desy, Peterson, & Brockman, 2011). Negative attitudes toward science are thought to begin by students during the primary school years and continue throughout the secondary and post-secondary years (Desy, Peterson, & Brockman, 2009; Haladyna & Shaughnessy, 1982). With the numerous variables that may affect the attitudes of students toward science two of the most leading are gender and the quality, rigor, of science instructional practices students encounter during their early academic lives (Desy, Peterson, & Brockman, 2011). Jewell (2011) defined attitude as a students' interest in a topic being learned. Over the past twenty years, the role of positive attitudes in science, and its affect on motivation, have been the premise for finding ways to encourage more students to enroll STEM courses, and enter into STEM fields (Desy et al., 2011). A concereted effort is being done to increase persons' motivation and interest in general, as well as determine ways of increasing motivation and interest in STEM courses and careers among URMs.

Motivation and interest in STEM among minorities. Prior studies suggested possessing a positive attitude is the fundamental foundation for developing an interest in science among adolescent students (Desy et al., 2011). Additional results suggested girls appear to exhibit more negative attitudes than boys towards science courses and career selection (George, 2006). Desy et al. (2011) indicated continual decrease in girls' attitudes toward science while matriculating from middle to high school. Sixth through 12th grade girls completed a survey that measured their science attitudes and interests. The results of the study showed females possessed more anxiety, but less motivation, in comparison to males in the study. Over the past twenty years, the National Science Foundation (2003) showed science educators strongly endorse positive attitudes in science as the best effort to urge more students to enroll in STEM courses, and think about a career in a STEM field. Atwater, Wiggins, and Gardner (1995) conducted a study on the low and high attitudes toward science of urban middle school students where it was found that Afrcan-American students exhibit positive attitudes toward science, and aim for careers in science. In spite of this, there is limited contact and accessibility to the information needed to achieve this goal (Atwater et al., 1995). The National Science Foundation (2002) suggested there are other probable indicators of science outcomes including enrollment in science courses, college majors, and career choice. It was also determined gaps are still in existence regardless of gains made by minority racial or ethnic groups as it relates to the course enrollment, and obtainment of science and engineering degrees (undergraduate, graduate, and doctoral) (National Science Foundation, 2002). Desy et al. (2011) found males had a more favorable attitude about science in comparision to females. The data collected also indicated females scored lower than males on scales measuring motivation and attitude toward science (Desy et al., 2011). Overall gender differences observed by the study showed disparities began to increase and become statistically significant with high school participants (Desy et al., 2011).

Brotman and Moore (2008) reported numerous large scale quantitative studies have shown girls have less positive attitudes for science than boys, and continue to decline with age.

Although experiences in college may be a deterant for girls in choosing a STEM major, research showed more females than males have already made the decision not to major in science at all (Sax & Arms, 2008). The National Science Foundation (2009) showed male college freshmen outnumbered female college freshmen by a two to one ratio as related to an interest in STEM. In order to realistically begin to grasp the concern of interest in STEM education and careers it is important to take into consideration the way in which students' interests change prior to entering college (Sadler, Sonnert, Hazari, & Tai, 2012; Bryan et al., 2011).

Sadler et al. (2012) studied career interests during high school years of students. The results of the study indicated a primary factor that predicted a student's career interest in STEM at the end of high school was the initial career interest upon entering high school (Sadler et al., 2012). The researchers also found high school females have a lower retention rate of interest in STEM careers as compared to high school males, and males remained stable while females decreased in their interest in STEM careers (Sadler et al., 2012).

Jewell (2011) examined how engagement in a robotics curriculum that offered more hands on activities had an affect on students' attitudes as it relates to grade, gender, and ethnicity. Jewell (2011) believed improving attitudes of students in science is the initial step to be taken to encourage to continue in STEM courses and fields after graduating from high school. Completion of the study on students in grades nine through 12 showed little to no difference in science inquiry of students according to grade, ethnicity, or gender (Jewell, 2011). There was a significant difference shown in students in grades twelve and 9 as it relates to students' attitude of enjoyment of science lessons, but no difference between gender (Jewell, 2011). A significant difference was shown with the data analyzed for science career interest with students in grades nine and 11, and nine and 12, and with ethinicities (Jewell, 2011). Jewell's (2011) study aids in showing the necessity to increase high school students' attitudes toward science so as to continue to increase the diversity of persons, more specifically, URMs entering into STEM courses and fields.

Social scientists recognize attudinal behavior, or interest, is learned, and subsequently can be altered (Jewell, 2011). Therefore, if interest can be adjusted it makes it more pertinent for secondary schools to strive to enhance students' overall interest in science regardless of gender or ethnicity (Jewell, 2011). If there is hope that issues pertaining to selection of STEM courses, majors, and career selection and retention can be addressed, a resolution must be found that develops the interest of young learners in STEM education. Interest has to be sustained through an extended period of time—one that lasts throughout the remainder of their years of schooling (Becker & Park, 2011). According to Dethlefs (2002), students showing a high interest and motivation in a specific subject often utilize greater cognitive processing skills. Utilization of these cognitive processing skills results in more advance conceptual comprehension, and high academic achievement (Dethlefs, 2002). Jewell (2011) theorized students are more likely to learn what is expected by educators if there is engagement in appropriate resources, and utilization of applicable instructional strategies.

Actions that can affect learning such as completion of homework, reading assigned pages or passages from the textbook, or attending class are based upon by a student's motives and attitude (Koballa & Glynn, 2010). Nonetheless, the influence of the motives and attitudes related to science learning and science achievement continues to be problematic to support through research (Koballa & Glynn, 2010). Students who engage in fun science learning experiences, and are viewed as personally fulfilling are more likely to adopt positive attitudes and increased motivation towards learning science, which lead to increased achievement.

Therefore, policymakers should take into consideration students' attitudes and motivaion in science curriculum when assessing affective outcomes of learning (Koballa & Glynn, 2010).

Academic Achievement

Academic achievement can best be defined asthe performance outcome indicating the level of accomplishment of a specific goal (Steinmayr et al., 2015). The field of academic achievement is broad, and includes numerous diverse educational outcomes. It is for this reason that academic achievement is dependent upon the indicators used to measure it (Steinmayr et al., 2015). For this study, academic achievement was defined as the level of mastery, numeric grade, attained on a high school human anatomy and physiology endocrine system unit test according to the Georgia Performance Standards. With agreement of the importance on both an individual and societal level of academic achievement, it is not unexpected to find academic achievement being at the forefront of research for scientists; especially in the educational and psychological facets of investigations (Steinmayr et al., 2015). In this study, individual academic achievement was the level of mastery a student attains in a human anatomy and physiology course; whereas societal academic achievement lends itself to determining one's level of academic achievement according to scores obtained on standardized achievement tests (e.g. SAT and ACT) and/or IQ assessments (Steinmayr et al., 2015).

Science teachers made the assumption a relationship exists between high school students' motivation to learn science and student academic achievement. Akbas and Kan (2007) conducted a study examining high school students' motivation and anxiety about enrolling in a chemistry class, and its effect on the students' academic achievement. The sample population consisted of high school students (N = 819) from 10 schools in Mersin, Turkey (Akbas & Kan, 2007). Results showed there was a linear relationship between students' level of motivation and achievement, but an inverse relationship between anxiety and achievement in the chemistry course (Akbas & Kan, 2007). As students' levels of motivation increased so did their achievement in chemistry, but conversely the opposite occurred with students level of anxiety (Akbas & Kan, 2007). As levels of anxiety increased a decrease in academic achievement was viewed, and academic achievement in the chemistry course appeared to increase as anxiety was decreased by students (Akbas & Kan, 2007).

Sevinç, Özmen, and Yiğit (2011) examined students (*N* = 518) in three schools to assess motivation levels of students toward science learning. Using the Students' Motivation Toward Science Learning scale (Tuan, Chin, & Shieh, 2005), Sevinç et al. (2011) investigated six factors—self-efficacy, active learning strategies, science learning value, performance goal, achievement goal, and learning environment situation. Data from the study showed there was a significant effect on students' level of academic success and motivation; as academic achievement increased so did students' level of motivation (Sevinç et al., 2011).

Britner (2008) conducted a study to examine if a relationship existed between motivation and high school students' science grades. Results of the study showed there was a relationship between the two variables, motivation and students' science grades. Bryan et al (2011) presented findings from a study conducted to assess the relationship among intrinsic motivation, self-efficacy, and self-determination to achievement. Data showed similarity between gender groups, male and female, in accordance with motivation, self-efficacy, and self-determination, and the relationship with academic achievement (Bryan et al., 2011). However, there was a significant difference in the achievement of students aspiring to take higher level science courses than students who did not aspire to take higher level science courses (Bryan et al., 2011). The students who aspired to take higher level courses had a mean score of 85.91 in comparison to those who did not aspire to take higher level courses, and had a mean score of 77.13 (Bryan et al., 2011).

In a research study conducted by Khoshnam, Ghamari, and Gendavani (2013), the researchers looked at the relationship between intrinsic motivation and happiness with academic achievement among high school students. The correlational study showed that a stastically significant relationship was found between intrinsic motivation and academic achievement among the 341 students used in the sample population (Khoshnamet al., 2013). A significant difference was also found in the scores for intrinsic motivation for males and females. Data showed female students to possess a higher level of intrinsic motivation in comparison to their male counterparts (Khoshnam et al., 2013).

Another area of concern in need of more investigative research pertains to the understandings and measurement of science achievement. Lee and Luykx (2010) reported that research programs place more emphasis on students' science work and empowerment as opposed to regularly measured academic achievement. The authors found a variation among research programs, and from different classroom assessments that focus primarily on memorization of contextual information (Lee & Luykx, 2010). With this knowledge and realization, science educators share the responsibility of improving science achievement, and getting rid of the achievement gaps it is still astonishing quantitative data from the research programs fail to speak to student outcomes (Lee & Luykx, 2010).

Science Achievement by Minorities

Barton, Tan, and O'Neill (2014) stated 50%, or more, of the world's population resides in an urban setting. In 2010 the U.S. Census Bureau reported 60% of the population lives in urban areas having more than 200,000 people, and an additional 21% live in urban clusters (U.S.

Census Bureau, 2010). Ramnarain (2011) conducted a study in South Africa looking at the equity issues in science education. The results of the study suggested migration to the suburbs by middle-class residents had produced achievement and resource gaps between suburban and urban science classes; consequently the inequalities found in the study are similar to those found in the U.S. (Ramnarain, 2011).

Council of Great City Schools (2011) in the U.S. reported urban education is continuously identifed as a failure, and therefore, under tremendous pressure to produce positive results. All urban schools, or the students and their experiences, are not the same (Barton et al., 2014). Of all urban school systems, 65 of the largest systems are responsible for educating 14% of students in public schools, and the 65 school systems account for less than one-half of the nation's 17,000 school districts (Council of Great Schools, 2011). Ironically, 14% also represents nearly a third of the nation's African-American students which means what transpires in urban schools in the U.S. affects this population (Meyer, Carl, & Cheng, 2010; Council of Great Schools, 2011).

The National Assessment of Educational Progress (NAEP) examined science abilities of students in three different grades—four, eight, and 12—who are enrolled in both public and private schools based on a scale of zero-300 (U.S. Department of Education, National Center for Education Statistics, 2015). In 2009, NAEP reported, white fourth grade students outscored black students 163 to 127 respectively (U.S. Department of Education, National Center for Education Statistics [NCES], 2015). The pattern in differences between racial and ethnic groups was similar with the eighth graders to the fourth graders (U.S. Department of Education, NCES, 2015). For students in grade 12, again white students outscored blacks 159 to 125, respectively

(U.S. Department of Education, NCES, 2015). Another assessment was conducted in 2011, and showed the following results:

> …average scores increased 1 point for White 8th-graders, 3 points for Black 8th-graders, and 5 points for Hispanic 8th-graders. The average science score of White 8th-graders continued to higher than the average scores of 8th-graders in all other racial/ethnic groups in 2011, but score gaps between White and Black 8th-graders…narrowed from 2009 to 2011. (U.S. Department of Education, NCES, 2015, para 3)

Achievement gaps by race and ethnicity, according to the NAEP, are being reduced as shown by the results of the assessments conducted in 2009 and 2011. Even so, African-American students' scores still remain overwhelmingly behind their Caucasian counterparts (U.S. Department of Education, NCES, 2015).

Norman, Ault, Bentz, and Meskimen (2001) looked at factors leading to the consistent achievement gap between African-American and Caucasian students in urban science classrooms. The study suggested there are multiple achievement gaps among urban science learners, and that the gaps are substantiated by numerous factors—race, ethnicity, and socioeconomic status—that affect urban communities (Norman et al., 2001). After probing a macro-analysis, Norman et al. (2001) hypothesized the achievement gap was more in relation to the demograpic settings—urban and suburban—of the students. Though, when Norman et al. (2001) compared the findings of their study with those for other racial and ethnic groups over the past 100 years, an argument was made suggesting science achievement gaps in urban classes are more reflective of a sociocultural perspective than that of racial differences. The findings of the study showed that at different points in time when the achievement gap was present it then proceeded to disappear for a number of different minority groups (Norman et al., 2001). This pattern was observed as the minority groups became more mainstream, or the majority , and not minority (Lee & Luykz, 2010) due primarily to migration from urban areas to the suburbs. Therefore, implications by researchers signify achievement gaps shifted as the populations changed (Lee & Luykz, 2010). There is also an association that the achievement gap is a reflection of the combination of other gaps which may have an effect on access to resources and schooling (Lee & Luykz, 2010).

There is familiarity with the notion minority students in urban schools have limited access to educational resources for classrooms across the U. S. This limitation to access includes, but is not limited to possession of up to date scientific texts, equipment, and extra-curricular activities focusing in science (Oakes, 1990). The inability to have access to resources has placed urban students at a disadvantage. Oakes, Muir, and Joseph (2000) showed through a California study analysis of national assessments and course-taking patterns that despite the increase in achievement and course-taking by all urban groups of students, a critical gap still remains between Caucasians and non-Caucasian student groups. The study also showed a correlation with inequalities in prospects to learn between the schools (Oakes et al., 2000).

Research studies propose a positive association between motivation and academic achievement as possible contributing factors creating success in science classes (Bryan et al., 2011; Khoshnam et al., 2013). The task of motivating students to be successful, and showing improvements in academic achievement can be daunting for educators and researchers. Thereby, a challenge that presents itself in educational entities is to find a way to increase student motivation while also increasing student academic achievement. The results of this study may help create a new plan to assist in finding an answer for this challenge. With the push by school districts to incorporate technology into the classroom it is the desire of this researcher to transform the traditional classroom setting into a more technologically advanced classroom through implementation of the flipped classroom. By creating a non-traditional classroom environment, and moving from a teacher-centered to a more student-centered setting it is with great expectation students will become more engrossed and vested in their learning (Carlisle, 2010). The flipped classroom will offer students more options for completing assignments, and being assessed on tasks using online software and tools with the potential for increasing student academic achievement, and student motivation.

Concentration on minorities and student diversity gives the assumption that the choices surrounding school organizations, assessments, curriculum, and instructional techniques affect various student populations in different ways (Lee & Lukyx, 2010). The results of academic successfulness then becomes dependent on the ability to integrate mainstream standards (Lee & Lukyx, 2010). There lies the assumption that when engaged in science instuction all students have access to particular educational resources away from the classroom, and urban students, or students who are poverish stricken, have to embrace learning habits that require a specific level of economic stability (Lee & Luykz, 2010).

Economic Influences and STEM

Researchers have examined disparities in schools' funding by race and poverty across states (Baker & Welner, 2010). A longitudinal study was conducted by Bifulco (2005) that analyzed the racial disparities in school funding by inspecting data collected from the 1980s through 2002 across all states. It was found black students' funding was 8.5% higher than white students' funding. However, when resources were adjusted for student needs such as poverty and regional labor market variation, black school districts had on average 3.2% to 15.8% less funding than white school districts (Bifulco, 2005).

The Education Trust (2006) reported consistent funding gaps between school districts having high and low poverty rates coupled with high and low student populations of color. The report also pinpointed states provide much lower levels of funding to districts with high poverty and higher minority rates (Education Trust, 2006). As a result, Education Trust (2006) found higher poverty and minority concentrated school districts continue to receive less funding from their respective states.

A disparity exists in the funding between school districts that directly determines that kinds of resources schools can provide for students (Museus et al., 2011). Research showed schools with larger inventories of resources were able to provide smaller classes for instruction which allows for positive contributions to student learning and achievement (Museus et al., 2011). This issue places racial and ethnic minority students at a disadvantage due to a history of racial and ethnic minority students attending schools that have less resources resulting in larger class sizes (Museus et al., 2011). According to May and Chubin (2003) students attending primary and secondary schools not receiving sufficient funding are usually unable to provide students with the most recent literature, instructional materials, laboratory equipment and materials, and proper technology as opposed to schools receiving more funding. The separatism in allocation of funds to schools creates a division that further hinders success in science and math for racial and ethnic minority students (Rendon & Hope, 1996). Disparities in school funding is said to be a contributing factor to inadequate preparation of racial and ethnic students in the STEM circuit (Museus et al., 2011).

An economic necessity exists for STEM education, and is one of many reasons, and perhaps the most influential, for why teaching science is important (Donovan, Mateos, Osborne, & Bisaccio, 2014). Studies showed in order to increase advanced economies’ gross domestic product (GDP) there needs to be a continuous source of scientists and engineers available to create and drive innovation (Hanushek, Jamison, Jamison, & Woessman, 2008; Roschelle, Bakia, Toyama, & Patton, 2011). If continuous creation, recruitment, and retention of scientists fail to take place, policy makers and the academic industry suggest that the competitiveness of the U.S. economy will decline (Donovan et al., 2014). After recruiting students, who would become future scientists, a decision needs to be made as to the best instructional methods for teaching science and mathematics content that would keep them motivated and interested in the content and field.

Instructional Teaching Methods

Traditional Teaching (Face-to-Face)

Traditional teaching methods often focus on methods considered to be teacher-centered rather than student-centered, and often observed as direct instruction. Teachers that indulge in this mode of instruction habitually use lectures, dissemination and presentation of materials, question and answer, and practice questions as techniques for learning new material (Clark, 2014). The expository-discovery continuum supports that no one teaching method is inherently better than another (Martin, 2012). Rather, the effectiveness of a given teaching method, whether expository methods, such as lecturing, or free discovery methods, such as problem-based learning, are dependent on myriad factors, including student ability, level of motivation, personality, context, and content (Martin, 2012). In fact, lectures have been shown to be an effective means to assist students with obtaining new knowledge (Schwerdt & Wupperman, 2011). Relan and Gillani (1997) argued traditional instruction is a primary cause of an out of date educational system. In a traditional classroom setting the following behaviors are frequently observed:

- The teacher talks more than the students
- Whole class instruction occurs more frequently than small groups or individual instruction
- Teacher determines how class time will be utilized
- The textbook is used to guide curriculum and instructional decision making
- Class is set up with desks/chairs arranged into rows facing the board (Relan & Gillani, 1997).

With direct instruction taking place students have minimal input as to what is learned, and most information is taught in isolation versus meaningful context (Clark, 2014). Lecturing to students is a manner where a large amount of information can be dispersed to large numbers of students. This approach is useful when basic skills are required, but does not allow for the students to learn conceptually. According to Steinmatz (2013), lectures merely give students an answer with hopes they will come up with a solution to the answer. The world of instruction is continuously changing just as the students in the classroom, and teachers are going to have to also adjust and change with the students. In doing so new instructional teaching methods need to be designed and implemented that will create the most engagement for learning.

Flipped Classroom

For many years, educators and educational researchers probed the efficiency of lecture based teaching methods (Roehl et al., 2013). Ritchhart, Church, & Morrison (2011) discussed the recognition of the hardships of teaching students how to comprehend as opposed to memorization. It should be the goal of the teacher to move students from simple memorization of facts toward a deeper learning, and use of active and constructive processes (Ritchhart et al., 2011). In order for this to occur, teachers must move from a classroom that is teacher-centered toward one that is student-centered (Ritchhart et al., 2011).

The flipped classroom is one instructional teaching strategy that transforms the paradigm of teaching and learning from teacher-centered to student-centered. Traditional measures that usually take place in the classroom now occur outside the confinements of the classroom (Lage, Platt, & Tregalia, 2000). It is in the flipped classroom instruction by the teacher can be redirected out of a larger learning space, and moved into a more individualized learning space with the assistance of various technologies (Hamdan et al., 2013). Educators from the Flipped Learning Network and Pearson's© School Achievement Services (2013) derived four features that allow for learning to take place in the flipped classroom—flexible environment, learning culture, intentional content, and professional educators

When creating a flexible learning environment teachers may physically rearrange the space to accommodate for the lesson permitting students to decide when and where they learn content (Hamdan et al., 2013). Instructors now create appropriate assessment systems to objectively measure mastery in ways more meaningful to students and the teacher. Shifting the learning culture is meant to let class time be for delving deeper into topics; thereby creating more powerful learning opportunities (Hamdan et al., 2013). Theoretically speaking, students can pace their learning, and teachers can maximize face-to-face interaction with students (Hamdan et al., 2013). Intentional content is used by teachers to get the most out of class time, and implement various methods of instruction involving active learning strategies, problem-based learning (PBL), and peer-peer instruction. Continuous thought is put in place as how to increase students' conceptual understanding (Hamdan et al., 2013). Employment of professional educators is important when executing flipped learning (Hamdan et al., 2013). It is the decision of the teacher to determine when and how to change direct instruction to individualized learning space from a larger group space, and capitalize on the face-to-face classroom time (Hamdan et al., 2013). Gojak (2012) stated:

> The right question for educators to ask themselves is not whether to adopt the Flipped Learning model, but instead, how they can utilize the affordances of the model to help students gain conceptual understanding, as well as procedural fluency when needed. ("To Flip or Not to Flip," para 6)

The purpose of the flipped classroom is to allow the instructor to become more of a facilitator in the class while also allowing time to be freed up for other instructional strategies (Milman, 2012). Milman (2012) stated that the premise behind implementation of the flipped classroom is:

> …the idea that rather than taking up valuable class time for an instructor to introduce a concept (often via lecture), the instructor can create a video lecture, screencast, or vodcast that teaches students the concept, freeing up valuable class time for more engaging (and often collaborative) activities typically facilitated by the instructor. (p.85)

Videos or screencasts created by teachers can be accessed whenever and wherever it is convenient by students. The easy accessibility for students to watch the videos—at home, in study hall, on the way home, or in a hospital—as often as necessary allowing students to come to class better prepared (Musallam, 2011). With increased preparation teachers now can utilize class time to assess each student's level of comprehension, and provide more individualized support to students (Hamdan et al., 2013). Providing more individualized support occurs by maneuvering the activities created for the class which creates ways for teachers to meet students at their level of preparedness (Hamdan et al., 2013). Table 1 shows an example of how time is differentiated in the traditional and flipped classroom as depicted in secondary school class setting.

Table 1

Comparison Of Class Time In Traditional Versus Flipped Classrooms

Traditional Classroom		Flipped Classroom	
Activity	Time (min)	Activity	Time (min)
Warm-Up Activity	5	Warm-Up Activity	5
Go over homework from previous night	20	Questions and Answer Time on Video	10
Lecture on new content	30-45	Guided/Independent Practice and/or Lab Activity	75
Guided/Independent Practice and/or Lab Activity	20-35		

Note. Adapted from *Flip your classroom: Reach every student in every class everyday* (p. 15), by J. Bergman and A. Sams, 2012, Alexandria, VA: ASCD.

Flipped learning is often been compared to online, distance, and blended learning due to video and screencasts components associated with it; but there are distinct differences. According to Oblinger and Oblinger (2005), online learning transpires from a remote location, and there is no face-to-face between teacher and students. With virtual learning, class meetings, assignments, and lectures take place online via a course management website (Hamdan et al., 2013). Blended learning has an online part that typically takes place during class time coupled with direct teacher-student contact (Allen, Seaman, & Garrett, 2007). The face-to-face interaction that occurs in this respect may not be different than what occurs in traditional classroom setting. This situation may very well take place in some flipped learning environments. Utilization of digital technologies to deliver content outside the confinement of the classroom does not guarantee there will be a drastic difference in what takes place during class (Hamdan et al., 2013). However, it does again allow for the shift to occur from being teacher-centered to student-centered learning (Hamdan et al., 2013).

While there is limited empirical research or extensive qualitative research on flipped learning, and its effect on student achievement there is a body of research that backs the primary mechanisms of the strategy (Hamdan et al., 2013). Advantages of utilizing the flipped classroom include improved student engagement, or active learning, individualized student guidance, more focused class discussions, and creativity by faculty while ensuring compliance of standardized curriculum (Millard, 2012). Michael (2006) and Prince (2004) looked at the effect of active learning in disciplines of science and found that active learning strategies supported the effectiveness of increasing student achievement and learning. Chaplin (2009) looked at classroom teaching and learning methods that were said to promote positive active learning in an introductory biology course. Results indicated active learning was associated with improved academic performance by students. Akingolu and Tandogan (2006) showed that with problem-based learning in science courses students reported having learned more, and improvement with their attitudes toward the class.

In a study performed at California State University Northridge, Enfield (2013) looked at the impact of the flipped classroom on students in an undergraduate multimedia class. The findings showed students benefitted from the new instructional approach finding it helpful and engaging (Enfield, 2013). Students also found quizzes attached to the video lectures were primary motivators for wanting to keep up with the video recordings (Enfield, 2013). Other results from the study showed students gained more confidence in their ability to learn a new topic (Enfield, 2013). Enfield (2013) proposed the flipped classroom may be a viable strategy to promote mastery-based education. Steinmatz's (2013) concluded although there was no definitive evidence showing why the flipped classroom worked, the results showed that of the 453 instructors who flipped their classrooms, 80% saw improvement in student attitudes, and 67% saw an increase in achievement via standardized test scores.

A case study was conducted at Byron High School in Minnesota in 2009 where students' performance on the state's mathematics test (Minnesota Comprehensive Assessments) and ACT composite scores were analyzed before and after implementation of the flipped classroom (Fulton, 2012). Due to budget cuts the math department rewrote the curriculum and adopted the flipped classroom model (Fulton, 2012). After flipping the classes, teachers reported increased engagement and academic performance by students during the first year (Fulton, 2012). By the third year of implementation the school reported more than 70% percent of the students successfully passing the state's math test (Fulton, 2012). An increase in students' composite ACT score was also observed, and a continual increase in students' scores was seen over the preceding years (Fulton, 2012). Another case study was completed at Clintondale High School located in the suburbs of Detroit, Michigan in 2010 where the school is centered around teacher lecturing, and 75% of the student population are low-income minority families. During the first semester of implementation failure rates decreased exponentially by approximately 33 percentage points (Green, 2012).

The Flipped Learning Network (FLN) conducted an online survey of 450 educators in 2012, and found that instructors connected the flipped classroom with increased student performance and attitudes (Hamdan et al., 2013). Approximately 66% of the educators who reported increased standardized test scores among their students after flipping the classroom

(Hamdan et al., 2013). Within the same survey, 80% of educators acknowledged improvement in students' attitudes toward learning content (Hamdan et al., 2013). The Public Broadcasting System (PBS) and Grunwald Associates (2010) surveyed 1400 pre-Kindergarten through 12th grade teachers and found 66% correlated videos with increased student motivation.

The reports by scholars and researchers have presented the positive effects of the flipped classroom with instruction. Although the majority of the reports are anecdotal, the sizeable number of persons that described successful execution of the strategy gives some indication as to the usefulness of the instructional method. However, there are concerns surrounding the creation and execution of flipped learning in traditional classrooms. As with any new instructional method there are objections associated with the flipped classroom. One problem is resistance by students due to the accountability now placed on them to do the work at home which may result in students arriving to class unprepared (Herreid & Schiller, 2013). Another downside could be instructors finding and/or creating quality videos for students to watch at home (Herreid & Schiller, 2013). Access to technology outside the class or school could potentially become an obstacle that would hinder being successful in the class (Siegle, 2014).

Stumpenhorst (2012) argued that the student-centered and active engagement and learning sections that occur in the flipped classroom represent what should already be taking place in the traditional classroom setting. It was also noted that the flipped classroom is not a well-defined model, but more so the result of instructors using varying tools to meet students' needs (Stumpenhorst, 2012). In a radio interview on Southern California Public Radio (2013), educator Gary Stager expressed his concerns with the flipped classroom. Stager stated the model places extreme emphasis on lecture and homework, and merely switches the position of the two (Southern California Public Radio, 2013). Stager noted the flipped classroom will continue to privatize education, and will result in the elimination of teaching jobs (Southern California Public Radio, 2013). More importantly, a concern was placed on unequal access by students to technology (Child Trends, 2012). Child Trends' (2012) survey showed 57% of children age three to 17 had use of the internet at home. It also indicated Hispanic and African-American children families who have lower incomes and whose parents are less educated have far less access to computers and internet (Childs Trends, 2012). It is probable these disparities will decrease over time, but as this transpires other ways exist where instruction can be delivered digitally (Hamdan et al., 2013). The simplest and easiest way would be to download the content onto a memory device that can be plugged into a computer at home (Hamdan et al., 2013). The content can also be burned onto DVDs that can be viewed on any computer away from school (Hamdan et al., 2013). As well as, videos can be made available via smartphones, iPods, and iPads (Hamdan et al., 2013). While these concerns are valid it should be noted for this research study 100% of the student population at North Star High School have access to the internet while at school, and more than 85% of the student population possess smartphones or iPhones that have internet access.

It is proposed increased motivation will be observed through the implementation of the flipped classroom, and its integration of technology. The desired behavior of increased motivation is consistent with science-learning behavior that explains human learning and motivation as viewed by Bandura (1986, 2001). According to Bryan et al. (2011) motivated science students obtain good science grades, and choose careers in science.

Summary

The research shows that there is a need for increase in enrollment in STEM courses, majors, and careers. Studies show one of the co-founding factors hindering students, specifically minorities and females, from entering the STEM fields is the lack of motivation, and academic preparedness, or achievement, upon entering post-secondary institutions (Koballa & Glynn, 2010). Recent data shows students make career decisions well before entering college, and therefore more emphasis needs to be put on reaching students not only in high school, but in earlier grades as well (Sadler et al., 2012; Jewell, 2011; Morgan, Farkas, Hillemier, & Maczuga, 2016).

If the goal of the U.S. is to largely increase the number of students pursuing STEM careers students need to be more developed beyond having a strong foundation in content (Barton et al., 2014). The ability to assist students with integrating knowledge and concepts from multiple content areas, while also applying those concepts and knowledge in a manner that will be most significant must also be executed (Barton et al., 2014). Most of all, support must be given to students so that they have an appreciation for both themselves and STEM (Barton et al., 2014).

There is a shortage of quantitative research that examines methods for increasing student motivation in science courses on the primary and secondary levels in urban high schools. Even fewer studies exists showing methods of increasing science motivation and increasing student achievement in an urban high school setting using the flipped class model. To date, only one study has been conducted showing the impact of the flipped classroom on high school students (Talley & Sherer, 2013); conversely, the study was completed in a high achieving school in rural area. The current study examined student motivation and academic achievement in a science course by using the instructional learning strategy, flipped classroom, not often used by teachers in an urban school setting.

CHAPTER THREE: METHODS

Overview

The purpose of this quantitative study was to investigate the effect the flipped classroom may have on urban African-American high school students' motivation and academic achievement in a high school science course. Studies have shown that there is a critical need to increase recruitment and retention of minorities, more specifically African-Americans in STEM majors and career fields (Herrera, 2011; Museus et al., 2011; Moakler & Kim, 2014; Sadler et al., 2014). Previous studies (Hossain & Robinson, 2012; Becker & Park, 2011; Tsui, 2007) have focused on numerous strategies and interventions (e.g. mentoring, partnerships, curriculum transformation, etc.), but no studies are available to show how flipped classrooms affect students enrolled in a science classroom. By examining the effects of the flipped classroom on students' motivation and academic achievement there is potential to determine if this is instructional strategy is a probable pathway for increasing enrollment in other STEM courses that could lead to increased enrollment in STEM majors or careers.

Chapter Three focused on the proposed methodology. The research design is discussed followed by the research questions and hypotheses associated with the study (see Table 2).

Table 2

Description of Research Questions, Theoretical Framework, Research Design, and Data Measurement

Research Question	Theoretical Framework	Research Analysis	Data Measurement
RQ 1	Self-Determination and Social Cognitive Theory	one-way ANCOVA	Science Motivation Questionnaire II
RQ 2	Self-Determination and Social Cognitive Theory	one-way ANCOVA	Human Anatomy and Physiology Unit Test

Detailed information pertaining to the sample participants and setting is discussed. Lastly, the instruments used to measure the dependent variables, motivation and academic achievement, the suggested procedures and procedures for conducting the recommended statistical analysis is presented.

Research Questions

The research questions for the study were:

RQ1: Is there a statistically significant difference in urban high school students' motivation scores, as measured by the Science Motivation Questionnaire II, when participating in the flipped classroom as compared to students who participate in the traditional classroom?

RQ2: Is there a statistically significant difference in urban high school students' achievement scores, as measured by the human anatomy and physiology endocrine system unit test, when participating in the flipped classroom as compared to students who participate in the traditional classroom?

Design

For this study, a quasi-experimental non-equivalent pretest-posttest control group design was conducted to determine the effects of the flipped classroom on urban high school students' motivation and academic achievement in a high school science course. This quasi-experimental non-equivalent pretest-posttest design was selected as a result of the inability to conduct randomization when obtaining the sample population; therefore, a control group was used with the knowledge that randomization of the sample is also not feasible due to the educational environment where the study was carried out (Gall et al., 2007; Rovai, Baker, & Ponton, 2013). Due to randomization of the sample not being possible, a pretest was employed to control for differences in motivation and academic achievement. Using the quasi-experimental design also increased the ecological validity of the study due to the environments being the same for both the study and under normal conditions (Schmuckler, 2001). This strengthens the internal validity of the study (Campbell & Stanley, 1963; Gall et al., 2007).

Hypotheses

The null hypotheses for the study were:

$H_0$1: There is no statistically significant difference in urban high school students' motivation scores, as measured by the Science Motivation Questionnaire II, when participating in the flipped as compared to students who participate in the traditional classroom.

$H_0$2: There is no statistically significant difference in urban high school students' achievement scores, as measured by the Human Anatomy and Physiology Endocrine System Unit Test, when participating in the flipped classroom as compared to students who participate in the traditional classroom.

Participants and Setting

Students

The sample population for the study was comprised of African-American students enrolled in a 12th grade human anatomy and physiology science course in an urban high school located in central northern Georgia. The participants were comprised of both females and males. Human anatomy and physiology is an elective science course taken during students' senior year of high school; because it is an elective course for students, prerequisites are not required to enroll in the course. Georgia Department of Education lists human anatomy and physiology as an elective course, but each school also has the flexibility to use the course as the fourth-year science requirement for graduation (Georgia Department of Education, 2008). Thus, at North Star High School, the course is the only science course offered to 12th grade students outside of

Advanced Placement (AP) courses such as AP Biology and AP Chemistry. Therefore, the course is a required for all 12th grade students for graduation unless the student is enrolled in an AP Course.The participants selected for this study were selected based on a convenience sample because the population was readily accessible to the researcher. Randomized sampling could not be completed due to district policy for scheduling and assigning of students into respective courses and classes prior to the beginning of the academic year, and teachers do not have input as to which courses they are assigned. Therefore, intact classes were utilized and students assigned to those classes were participants in the study as a result of pre-existing conditions.

According to Gall et al. (2007), a minimum of 50 participants should be chosen for a study using a quasi-experimental pretest-posttest research design and for sufficient statistical analysis sample size (Cohen, 1988). Rovai et al. (2013) suggested that a minimum of 15 participants per group should be used while having a minimum of 26 participants per group for statistical analysis having a moderate effect size (Cohen, 1988). For this study a suggested sample size of N= 128 (n = 64 per group) was used with a statistical significance level of α=.05, moderate effect size, and statistical power of .80 (Gall et al., 2007).

Student participation in this study was solicited by the researcher during various points of interaction with students, parents, and teachers. With permission granted by district and local school administration, the researcher first introduced and discussed the study with 12th grade faculty members inclusive of the instructors, science instructional coach, and 12th grade academy leader seeking participation in the study. Once teachers agreed to participate, the students were identified as the sample population and I elicited their participation. In order to gain student participants for the study, the researcher engaged parents and students during Senior Audit Night. The purpose of the event was to establish student's eligibility for graduation at the end of the academic year, and a time in which the majority of 12th grade students and parents were collectively present. A brief presentation was conducted by the researcher during the Senior Audit Night for parents and students regarding the study. During the presentation both parents and students were educated about the purpose and significance of the study, given an explanation of a flipped classroom, procedures to be followed during the study, risks and benefits of participating in the study, voluntary nature of study, and concluded with a question/answer period with dissemination of informed consent forms. Parents and students were made aware, and it was reiterated by the traditional class setting instructor, that all students would have access to technology and educational websites used in the flipped class setting at the conclusion of the study to ensure equitable opportunities for both groups. The researcher reminded parents of the importance of confidentiality by students in each group in order to establish and maintain validity of the study. If sample size is not obtained at Senior Audit Night, the researcher would present the study to parents and students again during the spring Open House. At each point of contact volunteer informed consent forms (see Appendix A) were available and distributed to parents and students.

North Star High School, a pseudonym, is medium-sized urban public school located in Northwest Georgia. The high school is a part of a school district located in an urban city in northwest Georgia. The school district is comprised of approximately 50,708 students, and 7,000 employees with 105 learning sites (Georgia Department of Education, 2015). North Star High School has an enrollment of 867 students comprised as follows: 308 in grade 9, 230 in grade ten, 143 in grade 11, and 186 in grade 12. The school's demographics include 95.8% Black, 3.3% Hispanic, and less than 1% multi-racial; the school is classified as Title 1 due to 100% of the school receiving free or reduced price lunch. Approximately 30% of the student population receives services as a part of the Program for Exceptional Children (PEC), a program that assists students needing services with learning or behavioral disorders to improve their academic achievement in school, and there are 110 full time faculty and staff (Infinite Campus, 2015). Participants in the study had access to computer technology per design of the infrastructure of the classroom; however, only those students enrolled in the treatment group, flipped classroom, had access to the video recorded material from their respective teacher.

Teachers

Teachers in the study were African-American females assigned to teach the 12th grade human anatomy and physiology science course. The teachers are single gender due to the science department being made up of only female instructors. All teachers possess the same State of Georgia teaching certification credentials by being certified in Broad Field Science. In order to obtain certification an educator must take and receive a passing score on the Georgia Assessment for the Certification of Educators (GACE) exam in Broad Field Science. Being granted a Broad Field Science certificate signifies the ability for an instructor to teach any science course offered in grades six through twelve in the State of Georgia (Georgia Professional Standards Commission, 2010). The average amount of teaching experience of teachers is 10-12 years. Further demographic information will be provided upon receipt and completion of the experimental portion of the study.

Science Classroom/Labs Setting

The infrastructure for all science classrooms and labs, have the same technology available for use by both teachers and students—Promethean© Board, classroom computers, and grade level shared laptop carts (PC and Macintosh). Students are able to use desks for individual assignments, and black table tops and counters to use for completion of collaborative assignments and tasks, such as laboratory experiments. Human anatomy and physiology is a science course offered to senior level high school students by the State of Georgia Department of Education, and is often used to complete the student's graduation requirement as either the fourth science or as an elective. The human anatomy and physiology course is not a course that has a state summative assessment used to measure mastery at the end of the course. Therefore, as a certified science teacher in the state of Georgia, a current science department chairperson, and as a former instructor of the human anatomy and physiology course, the researcher created a unit test to measure students' academic achievement. A unit test using the Mastering A&P Tool by Pearson© was created to measure the level of mastery by students on the standard and element(s) covered during the study. All instruction provided by teachers to students was aligned with the five curriculum standards governed by the State of Georgia Department of Education for human anatomy and physiology. The course entails discussion about the systems of the body—reproductive, digestive, endocrine, cardiovascular, integumentary, immune/lymphatic, skeletal, muscular, urinary, nervous, and respiratory (Georgia Department of Education, 2006). Although there are a list of standards given for the course there is not a scope and sequence, or pacing guide for when respective standards/elements are to be taught, which results in instructors of the course having flexibility of providing instruction in any order as long as instruction is in compliance with standards for the course. Therefore, the researcher had autonomy to select the unit and accompanying activities for the unit used during the study in accordance with the standards for the course (SAP1, SAP2, SAP3, SAP4, and SAP5) (Georgia Department of Education, 2006). For this study, the endocrine system was the unit examined for the length of the study. The endocrine system was chosen due to the unit being appropriate for the length of time for treatment for the study. The content covered in the endocrine system unit is not as dense as the content covered in the remaining 10 body systems, and in turn offered students opportunities for mastery in both instructional settings. Having taught the course in previous years, the endocrine system unit, on average, required approximately 1.5 weeks for successful completion by instructor, and mastery of standard by students. However, for this study, to ensure sufficient time spent on content, activities, and needed remediation, the length of time for treatment covered a total of four weeks. Bergmann and Sams (2011, 2013) suggested flipped classrooms be implemented one lesson unit at a time, and continuously refine as time progresses. According to Lodico, Spaulding, and Voegtle (2010), to ensure enough time has passed between administration of pre-and- posttests and that participants are not able to recall items from the pretest an average time of four to six weeks between instrumentation is recommended.

The instruction provided to the experimental and the control group was constant across all classes for the study. The control group received instruction using a traditional, face-to-face format; whereas, the experimental group received instruction using a flipped classroom format. Both groups participated in the accompanying laboratory experiment that coincides with the standard of study using the same laboratory manual and specimens. All curriculum content covered during the study was decided by the researcher to ensure equivalency in content material, curriculum standard, and element(s) presented to students during instruction. The content for both groups was presented in the same order and the same instructional strategies except where indicated in flipped class setting (Appendix E). Similarity in content must be adhered to in order to control for construct validity and instrumentation threat.

Flipped Classroom

Participants received content delivery through video lectures and some assignments using the educational website, Edmodo™. Edmodo™ is a free of charge online social learning community that was founded by two educators in 2008, and currently has more than 35 million members, to assist with bringing educators into the 21st century environment (Edmodo, 2014). Students created a username, password, and will then be provided with an access code (see Figure 5) to gain access to course material (e.g. videos, assignments, etc.).

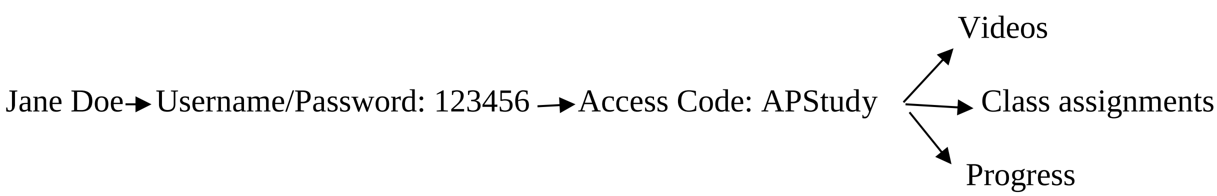


Figure 5. Flowchart of How Students Will Access Edmodo. This is an example of the process students will be required to use to gain access to Edmodo™.

Edmodo™ allows for student collaboration to occur outside of the confinements of the instructional period and physical classroom. Students without access to technology outside of the class in the form of a personal computer, cellular device, or tablet will be able to access the school’s library and computer labs. Students had the ability to use computers in the library or computer lab by which to access Edmodo™.

Traditional Classroom

Participants in the control group received traditional instruction in which content assignments were given face-to-face. Students in this group did not receive access codes to Edmodo™. Students utilized guided notes while receiving instruction and new material. Student participants in the control group did not utilize the educational website, Edmodo™; during the time period in which the study takes place. Students in the control group were not made aware of the technology platform students in the flipped class setting used. According to Onghena (2014), to help reduce resentful demoralization in intervention studies ensure participants are unaware of the treatment being applied. However, if this specific design control is not feasible the researcher should conduct a debriefing with participants afterwards to determine their comfort level with being assigned to the non-treatment group, and relate responses to the outcomes (Onghena, 2014). Resentful demoralization, as defined by Onghena (2014), is "threat to the construct validity of the treatment in intervention studies. This threat may occur in intervention studies in which comparison groups not obtaining a desirable treatment become discouraged or retaliatory, and as a result, perform worse on the outcome measures" (p. 1). Therefore, the researcher visited both class settings, without causing disruption to the instructional period, during the study to attempt to control for diffusion of treatment, and minimize the threat to internal validity. After completion of the study, the researcher debriefed with students, and correlated answer responses with data collected. Onghena (2014) stated that quasi-experimental studies involving treatment groups are often susceptible to internal threats like resentful demoralization, compensatory equalization, and diffusion of treatment. If required, the researcher would inform the control setting instructor to remind students, as stated in the parent presentation, that equitable access to all technology used by the treatment group, would be given to all students at the conclusion of the study that can be used as desired for the remainder of the academic session.

Instrumentation

Measurable instruments are needed in order to assess students' levels of science motivation and academic achievement. For this study, the instruments used to measure students' science motivation and academic achievement was the Science Motivation Questionnaire II (SMQ-II) (Glynn, 2011) and a Human Anatomy and Physiology Endocrine System Unit Test (Pearson©, 2014). The SMQ-II was used to measure students' science motivation. The Human

Anatomy and Physiology Endocrine System Unit Test was used to measure students' academic achievement.

Science Motivation Questionnaire II

The SMQ-II (Glynn, 2011) is a self-assessment instrument designed to measure students' motivation to learn college (science and non-science majors) or high school science content (Appendix B). The questionnaire was created to determine which students lack motivation and why motivation was lacking by those students (Glynn et al., 2011). The instrument was not only designed to measure students' motivation to learn science content, but also the relationship of motivation to other student characteristics and the interaction of motivation with instructional strategies (Glynn et al., 2011). The SMQ-II (Glynn, 2011) is comprised of 25 Likert-type scale questions that measure five components of science motivation—intrinsic motivation, self-efficacy, self-determination, grade motivation, and career motivation (Glynn et al., 2011). The SMQ-II (Glynn, 2011) was used in this study as a tool to effectively measure students' motivation to learn science (Glynn et al., 2011). This research instrument allowed for the examination of relationships between students' motivation and characteristics (Glynn et al., 2011) such as cultural backgrounds, achievement, and interest.

The SMQ-II was appropriate for the present study as it was originally developed and studied using high school students (ages 14-16) and college students to assess the results of the motivational beliefs of the participants in the study (Glynn et al., 2011). In both instances, there was an equivalent number of males and females volunteer participants for the high school study, and equal number of science and non-science majors (college participants). There was male-to-female ratio of 2:1 for college participants in both groups. The racial/ethnic make-up of the samples was similar to the population of the high school and public university. The survey was administered using a hard copy or online with ease of access (Glynn, 2011). For this study the survey was completed online using an electronic device (computer, cellular device, or tablet). Students were allowed to complete the survey anywhere. The amount of time required to complete the survey online is approximately five to ten minutes.

Each component of the SMQ-II (Glynn, 2011) is measured using five questions, and answers responses range from 0 to 4 (0 = never, 1 = rarely, 2 = sometimes, 3 = often, and 4 = always) (see Figure 6).

	Never	Rarely	Sometimes	Often	Always
Question 03: Learning science is interesting	0	1	2	3	4
Question 04: My career will involve science	0	1	2	3	4

Figure 6. Science motivation questionnaire-ii sample questions. Sample questions found on the SMQ-II (Glynn, 2011) used to measure science motivation.

Glynn et al. (2011) conducted two factor analyses to determine validity. The confirmatory factor analysis was conducted using the Analysis of Moment Structure (AMOS) program, and assessed the measurement model that examined the relationships among items and scales. The exploratory factor analysis examined students' responses to the questions as a result of revisions made to the original survey (Glynn et al., 2011). The reliability of the instrument was found by using Cronbach's alpha. The survey had a good reliability of Cronbach's $\alpha = .92$; in addition, the reliability for each scale was also good as indicated by the following scores: career motivation Cronbach's $\alpha = .92$, intrinsic motivation Cronbach's $\alpha = .89$, self-determination Cronbach's α = .88, self-efficacy Cronbach's α = .83, and grade motivation Cronbach's α = .81. A Cronbach's α of .80 or above is considered to be very good (DeVellis, 2003). The author of the instrument has given all researchers, and science educators, permission to utilize and manipulate the instrument as deemed appropriate provided correct citation is used giving credit to the developers (Glynn et al., 2011). The statement granting permission is shown on the home page of the instrument's website (http://www.coe.uga.edu/smq/, 2011) (see Appendix H).

Human Anatomy and Physiology Endocrine System Unit Test

The human anatomy and physiology endocrine system unit test (see Appendix D) was used to measure the dependent variable academic achievement. Although the human anatomy and physiology course is a science course offered by the State of Georgia Department of Education, it is not a course that has an End-of-Course assessment. Therefore, an assessment must be created. The instrument used to create the human anatomy and physiology endocrine system unit test was Pearson© Education's Mastering A&P Tool. Mastering A&P is a part of Pearson's© MyLab & Mastering collection of online homework, tutorials, and assessment products.

The test bank that used to create the unit test was obtained from the Mastering A&P Tool (Pearson© Education, 2015), and was comprised of hundreds of assessment questions used to measure mastery for concepts covered on the systems of the body. All questions were aligned with the curriculum standards governed by the State of Georgia Department of Education. Pearson© conducted a factorial analysis of the tool by examining 33 studies while analyzing the relationship between students' responses to questions on exams using the Mastering A & P Tool as a result of implementation in the science class. The reliability for all body system test questions were determined, and found to be acceptable for the endocrine system test bank that consists of 140 questions with a Cronbach's α = .89 (Pearson© Education, 2015). The Cronbach's alpha given is for the test bank for the endocrine system, and not the 30 multiple choice questions chosen for the pre-and-posttests; as a result, the Cronbach's alpha for the 30 multiple choice questions on the endocrine system selected for the study was calculated while collecting data on the pre-and-posttests. The summarization of the variables to be measured, how the assessments were formatted, and reliabilities of the instruments used in the study can be viewed in the table below (see Table 3).

Table 3

Descriptions of Instruments

	Science Motivation Questionnaire II	Human Anatomy and Physiology Unit Test
Variable measured	Motivation	Academic achievement
Assessment Format	Likert-type scale (survey)	Multiple choice
Reliability	Cronbach's α = .92	Cronbach's α = .89

The unit test covered 30 questions on the endocrine system, and all students took the same test. The unit test was administered to participants online during instructional time in class. Participants were given approximately 60 minutes to complete the unit test.

Procedures

After Institutional Review Board (IRB) approval from Liberty University I submitted a Research Request to the Department of Research and Evaluation for School Improvement to obtain school district approval to conduct the study at North Star High School. After receiving approval from the school district, a meeting was scheduled with administrative staff at North Star High School to discuss the study and the significance of the study to the school and district.

After which informed consent forms were distributed to participants at the 12th grade level meeting, and "Senior Audit Night" to obtain signatures on the informed consent form (see Appendix A) to participate forms. The researcher met with classroom teachers participating in the study to discuss the procedures. The classroom teachers participated in a content meeting to go over the expectations, the pre-and post-tests, in-class and out of class assignments, and the laboratory investigation that was conducted during the study. Teachers were provided with scripts (see Appendix I) to be read to students prior to beginning the SMQ-II.

The teacher selected to participate in the flipped classroom was randomly selected by me. Due to classes being intact researcher randomly assigned teachers, and corresponding students, to either the control or experimental group. The selected teacher engaged in two days of professional development training after school to become familiar with the logistics of a flipped classroom and to interact with Edmodo™. Video lectures, assessments, and documents housed on Edmodo™ were created by me to ensure accuracy of content taught and distributed to students. Training took approximately two hours a day for a total of four hours. The training included how to correctly log on and assign students tasks, activities, and videos on Edmodo™. The instructor learned how to view the students' usage of technology. The teacher selected for the control group engaged in one single two-hour training with the researcher to go over delivery of content to participants and laboratory experiment. For both teachers, the web address for accessing the SMQ-II (Glynn et al., 2011) online using Google Form™, and the scripts instructors (see Appendix I) was read to students while administering the survey and unit test was reviewed. A possible threat to study validity exists with teachers unintentionally implying one student group is better than another indicating possible bias in the study. To help control the study's validity, the researcher reminded teachers that conversations are not to be held with student participants in any manner suggesting that one group is better than the other. As suggested by Homer, Rew, and Torres (2006) and McMillan (2007), to ensure fidelity of the intervention, instructors for both class settings were given instructions for pre-and posttest administration and the same activities were given to both class settings for the length of treatment. It should be noted that the only difference between the activities that were completed during the study were the medium used to complete them. Researcher also reminded parents during the parent informational session that authenticity of the study relies on students' honesty when responding to questions on the survey, unit test, and when completing assignments in and out of class. Parents were also asked by the researcher to not converse or imply to participants that one class setting is better than the other. To help control for construct validity in the form of compensatory equalization, the researcher asked parents and instructors not to provide additional activities that could potentially match the effect of the intervention (McMillan, 2007).

The study began by having classroom teachers administer the SMQ-II during the beginning of each class period for both groups—the experimental (three classes) and control (three classes)—which should take approximately five to ten minutes. Afterwards, each teacher administered the online 30 multiple choice human anatomy and physiology endocrine system unit test (Pearson© Education, 2015) to students using the Mastering A&P Tool. The SMQ-II (Glynn et al., 2011) and the unit test both served as pretests for measuring difference in groups for motivation and academic achievement. Students completed both the survey and the unit test online using Google Forms™, which will allow the researcher to gather and analyze the data.

After the pretests, the control and treatment groups received instruction. The teacher assigned to the control group provided participants with content delivery and assignments using traditional lecture format and verbal directions for completion of assignments in class. The teacher assigned to the experimental group provided participants with directions and demonstrations of how the class would be implemented for the next four weeks using Edmodo™. Students created their Edmodo™ accounts to gain access to the materials provided for the unit being covered in the class for the next four weeks. Assignments completed by both groups were scored and reflected in each teacher's electronic grade book (Infinite Campus) to ensure equivalency of content covered in class, mutualistic formative assessments, and completion of assigned laboratory experiment. As a teacher at North Star High School, the researcher nor the researcher's students were participants in the study. Thus, fidelity of treatment was conducted through random visits to both classrooms. The researcher looked for classroom instruction relative to the standard and element(s) slated to be covered during the study. Productivity was assessed based on the number of students in the experimental group utilizing the technology to complete assignments as instructed by the teacher; and ensuring correct body system content was taught to students according to the standards/elements of the course. The researcher also had access to the Edmodo™ site in order to ensure students are logging on to the site to complete assignments during the allotted time period of the study while in class and at home.

At the conclusion of the four-week study, the teachers administered the online Human Anatomy and Physiology Endocrine System Unit Test (Pearson© Education, 2015) to students to measure the level of mastery by students. There is a possible confounding construct and level of construct threat that exist with the study treatment being four weeks. Data obtained may or may not be affected by the direct result of the length of time for study treatment. However, the length of treatment was four weeks due to sufficient time for completing the endocrine system unit, and to help prevent interaction bias; the average time between first and second administration of instruments is four to six weeks (Lodico et al., 2010). At the end of the administration of the unit test, students completed the SMQ-II (Glynn et al., 2011). Teachers read the script provided by the researcher that was read to students giving directions as to how to complete the survey (see Appendix I). Data collected from students who did not return their assent to participate forms was utilized in the study. Scores were used for grading purposes as the unit test was a part of the provided instructional curriculum, but scores were not a part of the statistical analysis procedures nor will the student(s) participate in the completion of the SMQ-II.

Data Analysis

Two separate one-way analysis of covariance (ANCOVA) were carried out to test the null hypotheses. The ANCOVA statistical procedure is appropriate when equality between groups is attempted by using a covariate such as a pretest—SMQ-II and the human anatomy and physiology unit test. The ANCOVA statistical method is more appropriate when one or more covariates exist, and utilized to amend for differences in pretest scores (Tabachnick & Fidell, 2007; Rovai et al., 2013). The independent variable used in the study was type of classroom (flipped, traditional). The dependent variables were motivation and academic achievement, and the controlling variables (covariate) were the corresponding pretests. An analysis of variance was used in the limited number of studies that produced empirical results on the flipped classroom. Previous studies support the use of ANOVA (Rice et al., 2013, Missildine et al., 2013; Strayer, 2012).

First, independent *t*-tests were conducted using the scores from the pretest to determine whether a significant difference in scores was found based on the assignment of groups prior to the implementation of the treatment (flipped classroom). If no significant difference between the scores for the control and experimental groups is found, meaning the groups do not differ, then two separate one-way analysis of variance (ANOVA) analyses would be used instead of the ANCOVAs. If a significant difference between the scores for the control and experimental groups is found, meaning the null hypotheses were rejected, then two separate one-way ANCOVA analyses would be performed, and the pre-test would be considered a covariate.

A number of statistical texts recommend varying ways of determining a sufficient number of participants for the sample population of an ANCOVA. Gall et al. (2007) recommended a minimum of 50 participants be chosen for a study using a quasi-experimental pretest-posttest research design for sufficient sample size, and for sufficient statistical analysis sample size (Cohen, 1988). Rovai et al. (2013) stated at minimum 15 participants per group be used while having a minimum of 26 participants per group for statistical analysis while having a moderate effect size (Cohen, 1988). For this specific study, a sample size of $N= 128$ ($n = 64$ per group) was used while having a statistical significance level of $\alpha=.05$, a moderate effect size and statistical power of .80 (Gall et al., 2007). The significance level used was $p < .05$. For ANCOVA partial eta squared (η^2) statistic was used to determine the effect size (Rovai et al., 2013) coupled with interpretation using Cohen's *d* (Cohen, 1988). The assumptions to be determined through assessment of different analytical methods are normality, testing of variances and covariances, identifying extreme outliers, linearity, and homoscedasticity. Creation of a histogram or the Kolmogorov-Smirnov test was conducted to test for normality. Kolmogorov-Smirnov would be selected versus Shapiro-Wilk due to the sample size being greater than 50. Normality is assumed if non-significant results ($p > .05$) are found, then tenability of assumption is indicated, and normality is assumed (Rovai et al., 2013). Assumption that population distribution has equivalent variances and covariances. The Levene's Test was conducted to examine the assumption of equal variance (Rovai et al., 2013).

Boxplots were used to identify outliers involving the two dependent variables, motivation and academic achievement. According to Tabachnick and Fidell (2007) stated having five percent or less of outliers is acceptable for variables. However, if outliers were found to be present the dependent variables must be examined to check for extreme outliers. An extreme outlier will have a *z*-score of +/- 3.29 (Tabachnick & Fidell, 2007; Rovai et al., 2013). In an effort to keep the power of the study, the outliers would remain,or be removed, if found to not unfavorably influence the data. ANCOVA and ANOVA statistical methods are said to be robust to presence of outliers if all of the outliers fall within the plausible limits of the respective dependent variable(s) and means, medians, and the 5% trimmed means are similar in value (Tabachnick & Fidell, 2007).

Assumption of linearity determines that approximation of the relationship between a straight line and two continuous variables which is the amount of change found between scores on two variables are constant for the entire range of scores for the variables (Rovai et al., 2013). Homoscedasticity assumption shows that variability in the scores for one variable is generally similar at each value of a second variable (Rovai et al., 2013). In order to determine assumption of linearity and homoscedasticity a scatterplot was created. This procedure was completed using SPSS stasticatical application.

The focus of this quasi experimental, non-equivalent pretest-posttest control group design experiment was to examine the effects of the flipped classroom on urban high school students' motivation and academic achievement in a science course. The group design was classified as non-equivalent due to groups being as similar as possible when compared to one another, however, uncertainty of being equally comparable exists lending groups to be unequal (Rovai et al., 2013). For this study, the number of students in each group may not be equal, and the gender equity may not be balanced for each group. As stated earlier, intact classes were assigned by the randomized selection of teacher for the control and treatment group. The students of concern for the experiment were students enrolled in a public school system located in northwest Georgia. In the next section, the findings of the research study are presented, and the results of each hypothesis tested are discussed.

CHAPTER FOUR: FINDINGS

Overview

The purpose of this quantitative study was to examine the effect of the flipped classroom on urban high school students' motivation and academic achievement in a science course at North Star High School. Along with adding to the current body of literature on the flipped class, this study also builds on assessing factors that influence science achievement and motivation. The study was conducted using 136 African-American students enrolled in a 12^{th} grade human anatomy and physiology science course in an urban high school located in northern Georgia. All participants were current students in the intact, classes created before the study as a result of scheduling by North Star High School, science course for all human anatomy and physiology classes. This chapter presents results of data collected during the research study as it relates to the research questions and hypotheses discussed in chapters one and three, and concludes with a summary of the results.

Research Questions

The research questions for the study were:

RQ1: Is there a statistically significant difference in urban high school students' motivation scores, as measured by the Science Motivation Questionnaire II, when participating in the flipped classroom as compared to students who participate in the traditional classroom?

RQ2: Is there a statistically significant difference in urban high school students' science achievement scores, as measured by the human anatomy and physiology endocrine system unit test when participating in the flipped classroom as compared to students who participate in the traditional classroom?

Null Hypotheses

The null hypotheses for the study were:

$H_0$1: There is no statistically significant difference in urban high school students' motivation scores, as measured by the Science Motivation Questionnaire II, when participating in the flipped classroom as compared to students who participate in the traditional classroom.

$H_0$2: There is no statistically significant difference in urban high school students' science achievement scores, as measured by the human anatomy and physiology endocrine system unit test, when participating in the flipped classroom as compared to students who participate in the traditional classroom.

Descriptive Statistics

At the start of the research study there were a total of 136 participants (N = 136); however, 135 participants (N = 135) participated in completion of posttests due to one student being absent on the date of posttest administration by teachers. For this research study, all participants were African-American, 12th grade students enrolled in a human anatomy and physiology course. Demographics on sex of participants were not collected to ensure anonymity of participants as some school districts, such as those served by the Georgia Department of Education, do not release demographic information that would enable identification of participants.

After removal of outliers, there were 123 participants (N = 123); however, 122 participants (N = 122) were included in the statistical analysis due to one student's absence on the date of posttest administration by teachers. The descriptive statistics for the flipped classroom were as follows: A total of 61 endocrine system unit test pretest scores, which assessed student academic achievement, had a mean of 8.07 (SD = 2.38); 60 posttest scores had a mean of 21.72 (*SD* = 7.36). A total of 61 SMQ-II pretest scores, which assessed student motivation, had a mean of 70.56 (*SD* = 19.25); 60 posttest scores had a mean of 75.82 (*SD* = 16.26).

The descriptive statistics for the traditional classroom were as follows: A total of 62 endocrine system unit test pretest scores had a mean of 7.82 (SD = 3.20); 62 posttest scores had a mean of 21.44 (*SD* = 7.82). A total of 62 SMQ-II pretest scores had a mean of 68.66 (*SD* = 15.12); 62 posttest scores had a mean of 68.97 (*SD* = 14.83). Skewness and kurtosis were calculated after the removal of outliers, and found to be closer to "0," which suggested a more normal distribution of scores (Warner, 2013). Descriptive statistics for the pre-tests and posttests, endocrine system unit test and Science Motivation Questionnaire-II (SMQ-II), used in the study can be found in Table 4.

Table 4

Endocrine System Unit Test and SMQ-II data descriptive statistics

Variable	Classroom Type	*N*	*M*	*SD*
Endocrine System Unit Pretest	Flipped	61	8.07	2.38
	Traditional	62	7.82	3.20
Endocrine System Unit Posttest	Flipped	60	21.72	7.36
	Traditional	62	21.44	7.82
SMQ-II Pretest	Flipped	61	70.56	19.25
	Traditional	62	68.66	15.12
SMQ-II Posttest	Flipped	60	75.82	16.26
	Traditional	62	68.97	14.84

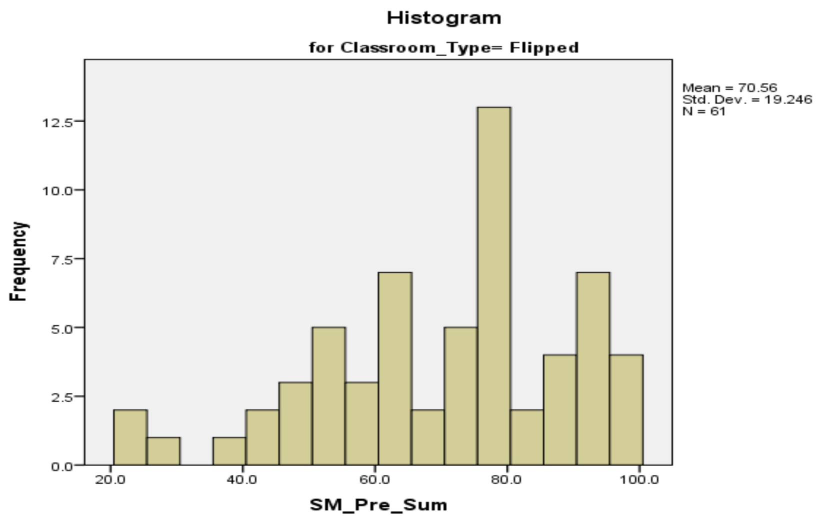
Results

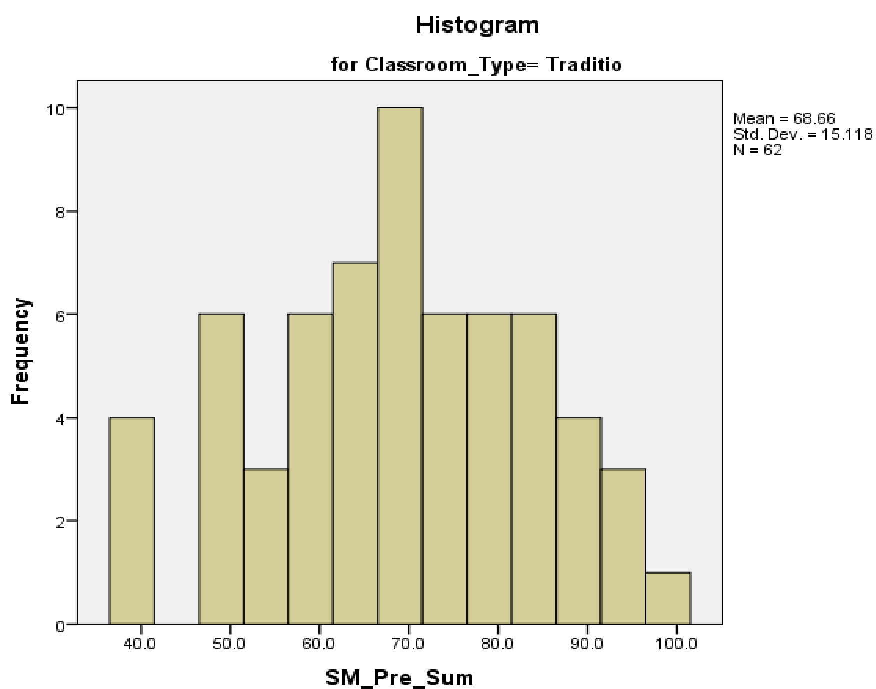
Null Hypothesis One

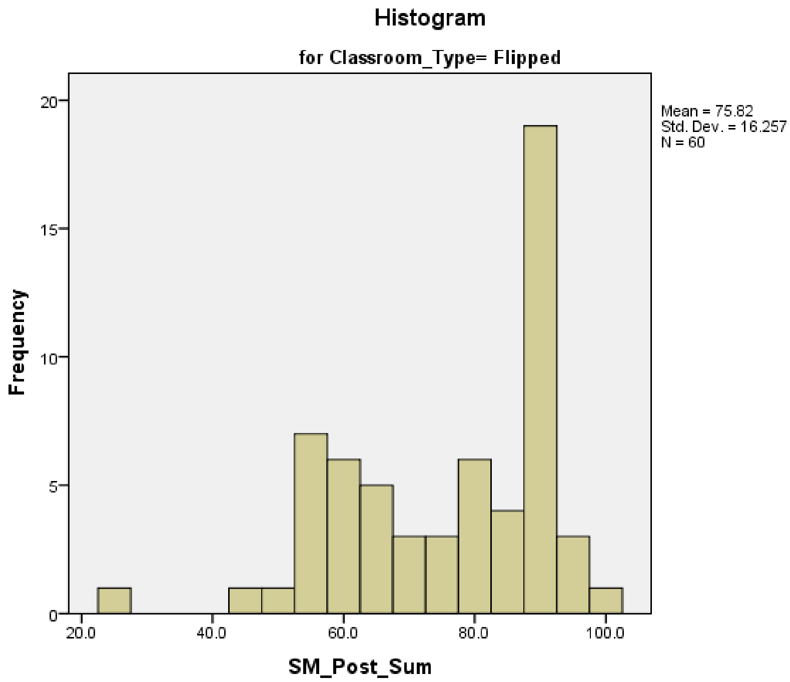
Null Hypothesis One stated there is no statistically significant difference in urban high school students' motivation scores, as measured by the Science Motivation Questionnaire II, when participating in the flipped classroom as compared to students who participate in the traditional classroom. An independent *t*-test was used to analyze the first null hypothesis. Assumption testing was conducted prior to running the analysis and is explained in the next section.

Assumption testing. An independent samples *t*-test was conducted to examine whether the mean scores of the SMQ-II Pretest were significantly different between the classroom setting (flipped and traditional). There was no significant difference in pre-test scores between the flipped class setting (M = 70.56, *SD* = 19.25) and traditional class setting (M = 68.66, *SD* = 15.12), $t(121) = .61$, $p = .54$, two-tailed. The magnitude of the differences in the means (mean difference = 1.90, 95% CI: -4.28 - 8.07) was very small (eta squared = .00); as a result, it was not necessary to use ANCOVA to control for preexisting differences (Tabachnick & Fidell, 2013).

Normality. Normality was examined using histograms. Inspection of the histograms revealed a normal distribution for the Science Motivation Questionnaire II pretest data for the flipped and traditional class settings, and posttest data for the traditional class setting. A slightly negative skewed distribution was revealed for the Science Motivation Questionnaire II posttest data for the flipped class setting (see Figure 7). An examination of normal probability plot (Q-Q Plot) (see Figure 8) and Detrended Normal Q-Q Plot (see Figure 9) was completed to further determine normality. The normal q-q plot and the detrended normal q-q plot indicated some deviation from normality. According to Rovai et al. (2013), "…real-world data will almost always show some variation from the theoretical normal model" (p.178).







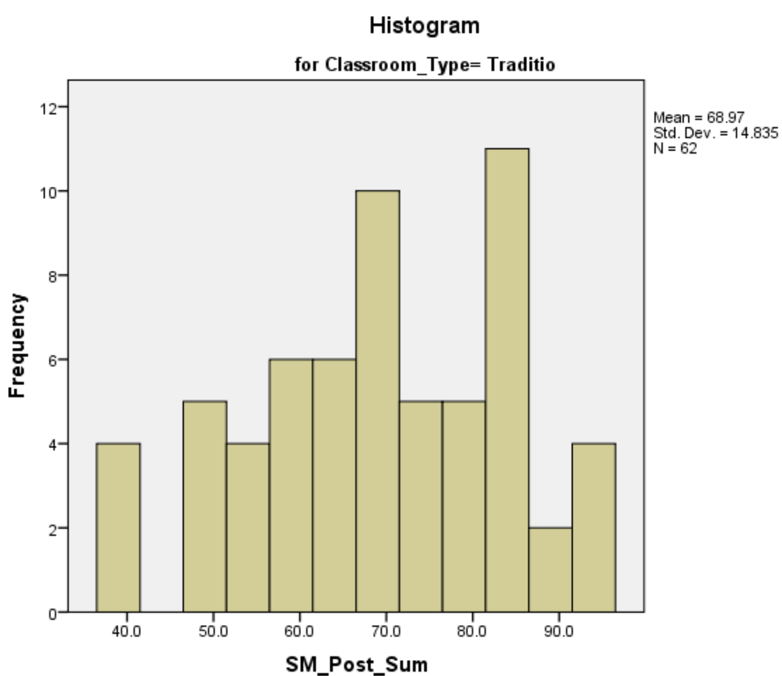
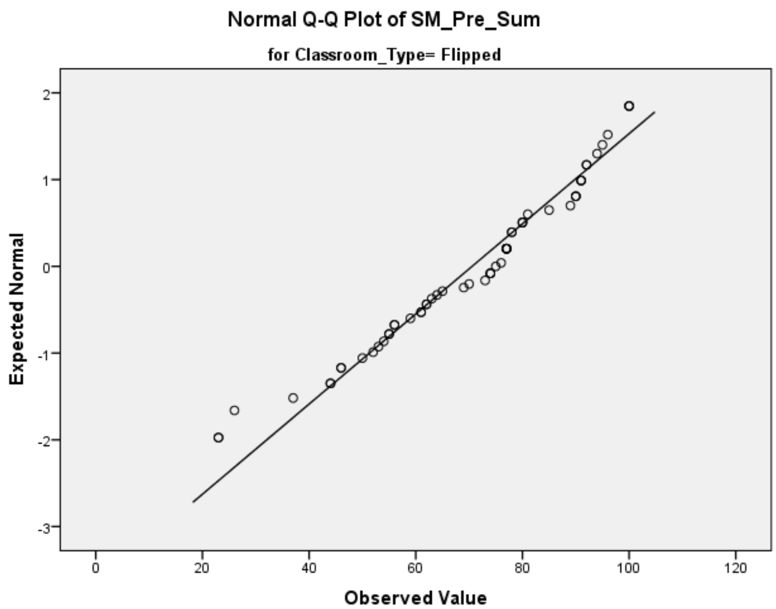


Figure 7. Histograms of distribution of pretest and posttest scores for SMQ-II according to class type.



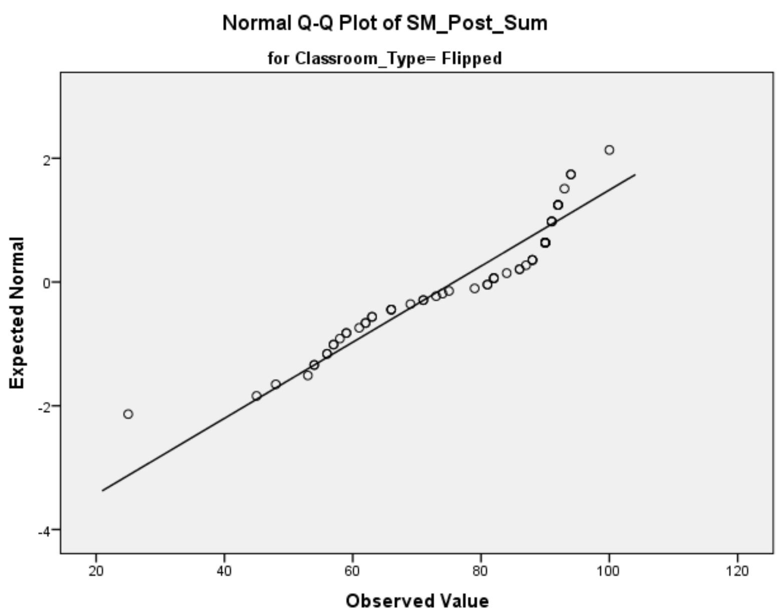
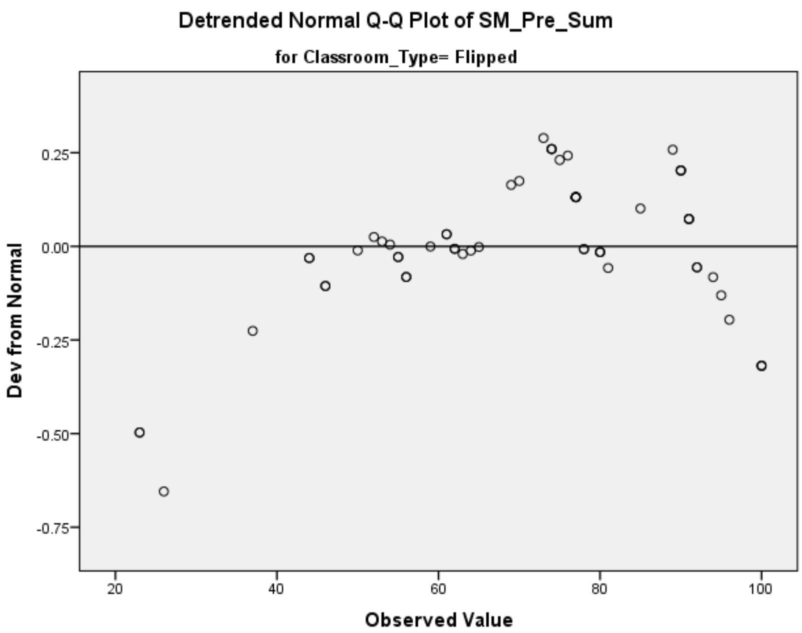


Figure 8. Normal Q-Q plot of SMQ-II pretest and posttest scores, flipped class.



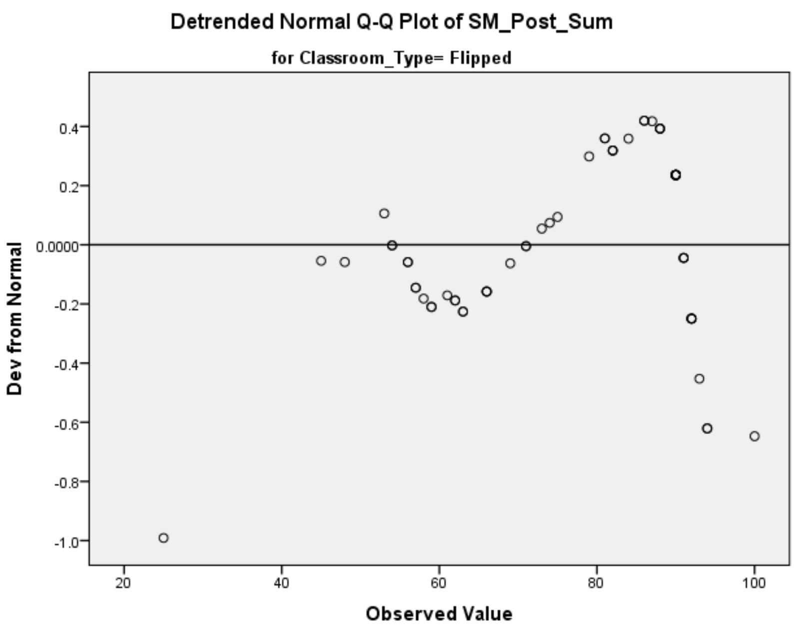


Figure 9. Detrended Normal Q-Q Plots for SMQ-II pretest and posttest, flipped class.

To determine if violation of assumptions of extreme outliers occurred there was an inspection of boxplots. Inspection of boxplots indicated that no violation of assumptions of extreme outliers for the Science Motivation Questionnaire II data. Therefore, assumption of no extreme outliers was tenable (see Figure 10).

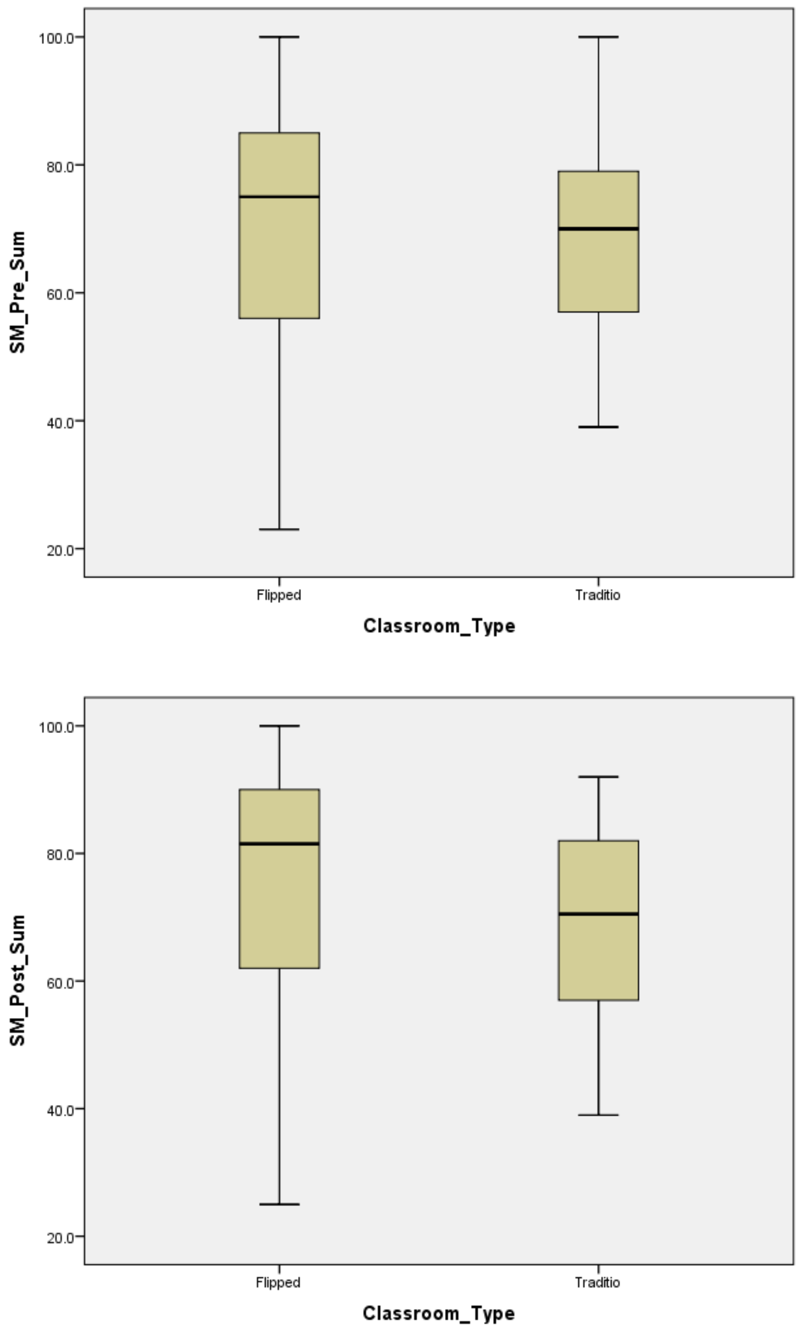


Figure 10. Boxplots for SMQ-II pretest and posttest, flipped and traditional classes.

Since the study contained more than 50 participants, results of Kolmogorov-Smirnoff (Tabachnick & Fidell, 2013) were utilized to ensure there was not a violation of assumption of normality for SMQ-II Pretest, flipped class setting (*p* = .01 which was less than α = .05), and traditional class setting (*p* = .20 which is greater than α = .05) (see Table 5). However, the mean of any random variable will be approximately normally distributed as sample size increases according to the Central Limit Theorem (CLT) (Stevens, 2009; Tabachnick & Fidell, 2013). Therefore, with a sufficiently large sample size (*n* > 100), deviations from normality will have little effect on the results (Tabachnick & Fidell, 2013).

Table 5

SMQ-II tests of normality.

Class Type		Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	Df	Sig.	Statistic	df	Sig.
SMQ-II Pretest	Flipped	.128	61	.014	.952	61	.019
	Traditional	.086	62	.200	.975	62	.227
SMQ-II Posttest	Flipped	.168	60	.000	.902	60	.000
	Traditional	.097	62	.200	.957	62	.029

Variance. The assumption of homogeneity of variance for the Science Motivation Questionnaire II pretest data was examined using Levene's Test. Levene's test measures the hypothesis that the variances are equal across the groups (Field, 2005; Rovai et al., 2013). According to Rovai et al. (2013), Levene's test is accepted as robust when deviations from normality are observed. Levene's test was not significant; therefore, the assumption of homogeneity of variance was tenable for the Science Motivation Questionnaire II pretest data, $F(1,121) = 3.53$, $p = .06$.

Correlation. The Pearson product moment correlation coefficient, *r*, was calculated to reveal if the dependent variables, academic achievement and motivation, were correlated. A correlation measures the relationship between variables; if a significant relationship is found to exist, the two variables are said to covary (Rovai et al., 2013; Warner, 2013). A very weak, negative correlational relationship was found between the dependent variables, academic achievement and motivation, $r(122) = -.14$, $p > .05$. The coefficient of determination was calculated to determine how much variance the two variables shared, and found to be 1.96% shared variance. A MANOVA examines the interaction between variables, and determines if groups differ on more than one dependent variable (Gall et al., 2007). As a result of the insignificant correlations among the dependent variables, the MANOVA was not conducted. An examination of the scatterplot further confirmed a weak correlation between the two variables, academic achievement and motivation (see Figure 11).

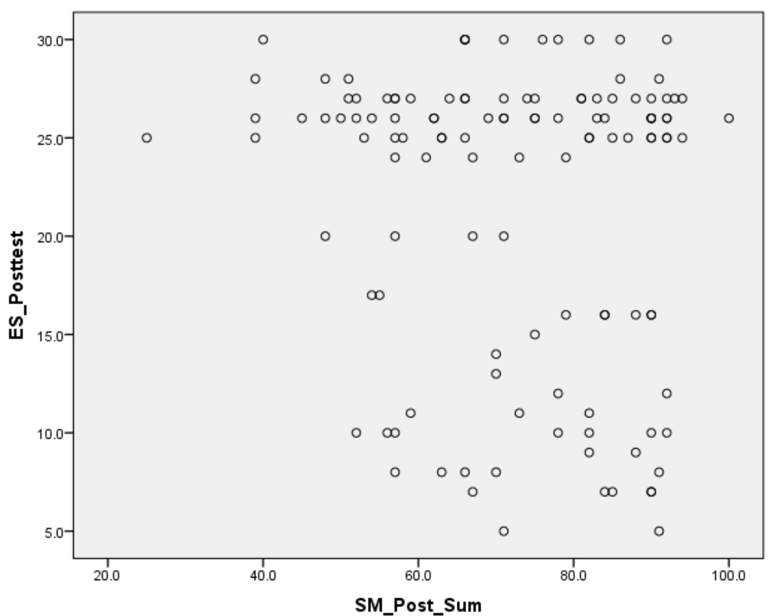


Figure 11. Scatterplot of dependent variables, academic achievement (Endocrine System Unit Test) and motivation (SMQ-II).

Reliability. Reliability testing was conducted to examine the internal consistency of responses to a group of questions. The reliability measure, Cronbach's alpha, for the Science Motivation Questionnaire II was calculated as 0.95. A Cronbach's alpha of 0.95 indicates excellent reliability (Tabachnick & Fidell, 2013).

Analysis results. The analysis used to analyze the first null hypothesis was an independent *t*-test instead of the between subjects analysis of variance (ANOVA) due to the independent variable, classroom type, only having two levels—flipped and traditional. According to Rovai et al. (2013), the between subjects ANOVA is appropriate when there is a need to compare the means of three or more groups, and the independent *t*-test is used to compare means of two groups. Both analyses are based on similar mathematical models, and "…produce identical *p*- values when two means are compared" (Rovai et al., 2013, p. 296). The analysis of covariance (ANCOVA) was not used because there was no statistically significant difference in Science Motivation Questionnaire II pretest scores for the flipped and traditional class settings.

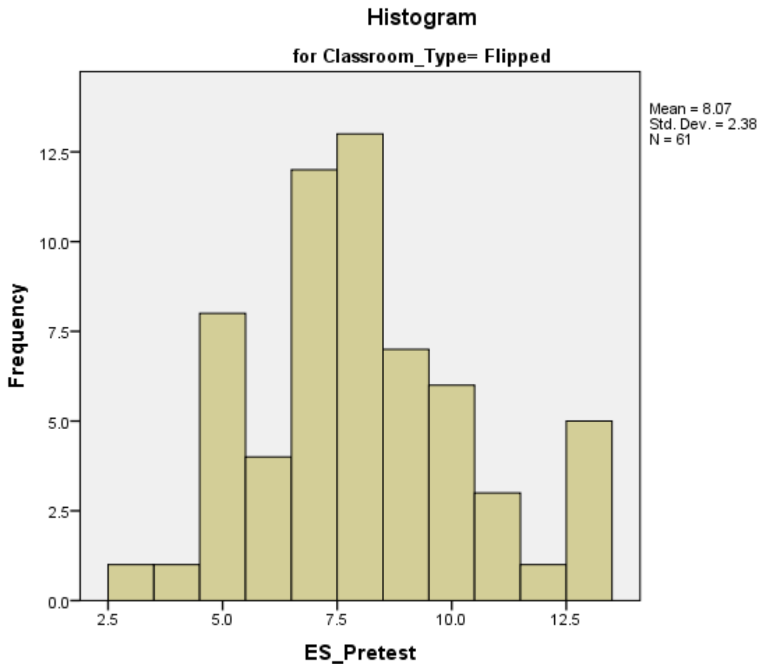
An independent *t*-test was conducted to compare the Science Motivation Questionnaire II posttest scores for flipped and traditional class settings. There was a statistically significant difference in posttest scores for flipped class setting (M =75.82, SD = 16.26) and traditional class setting (M = 68.97, SD = 14.83), $t(120) = 2.43$, $p = .02$. The magnitude of the difference in means (mean difference = 6.85, 95% CI: 1.27 to 12.42) was very small (eta squared = .05). Although a statistically significant difference in the scores was found, the results should be cautiously accepted due to the very small effect size of the difference in means.

Null Hypothesis Two

Null Hypothesis Two stated there is no statistically significant difference in urban high school students' achievement scores, as measured by the human anatomy and physiology endocrine system unit test, when participating in the flipped classroom as compared to students who participate in the traditional classroom. An independent *t*-test was used to analyze the second null hypothesis. Assumption testing was conducted prior to running the analysis and is explained in the next section.

Assumption testing. An independent samples *t*-test was conducted to examine whether the mean scores of the Endocrine System Unit Test pretest were significantly different between the classroom setting (flipped and traditional). There was no significant difference in scores for the flipped class setting (M = 8.07, *SD* = 2.38) and traditional class setting (*M* = 7.82, *SD* = 3.2), *t*(121) = .48, *p* = .63. The magnitude of the differences in the means (mean difference = .24, 95% CI: -.77 to 1.25) was very small (eta squared = .002); thus, analysis of covariance (ANCOVA) was not used to control for preexisting differences (Tabachnick & Fidell, 2013).

Normality. Normality was also examined using histograms. Inspection of the histograms revealed a normal distribution for the Endocrine System Unit Test pretest data for the flipped and traditional class settings (see Figure 12). An examination of normal probability plot (Q-Q Plot) (see Figure 13) and Detrended Normal Q-Q Plot (Figure 12) was completed to further determine normality. The Normal Q-Q Plot and the Detrended Normal Q-Q Plot indicated some deviation from normality. According to Rovai et al. (2013), "…real-world data will almost always show some variation from the theoretical normal model" (p.178).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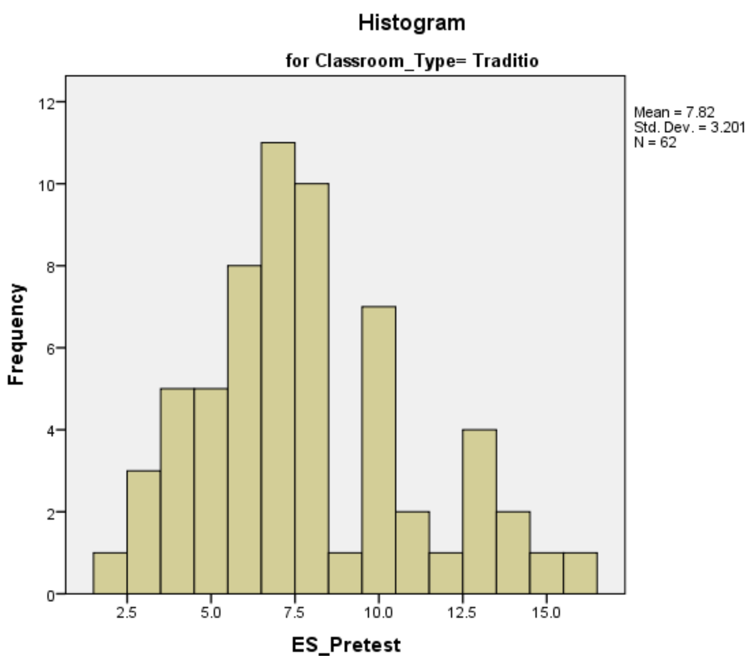
10.0
12.5
ES_Pretest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N = 62
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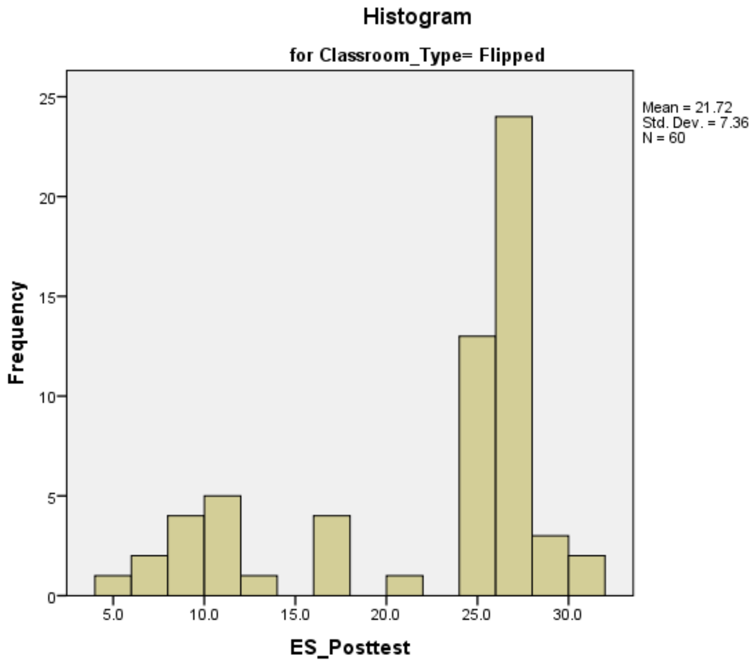


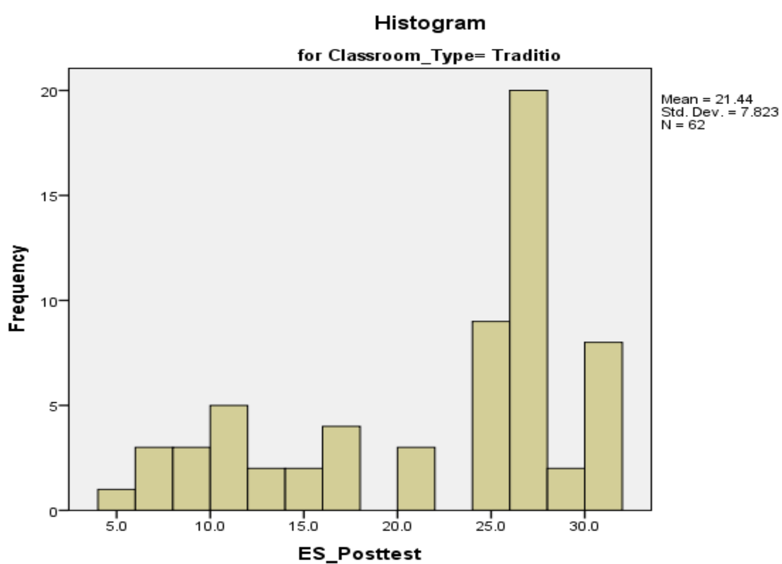
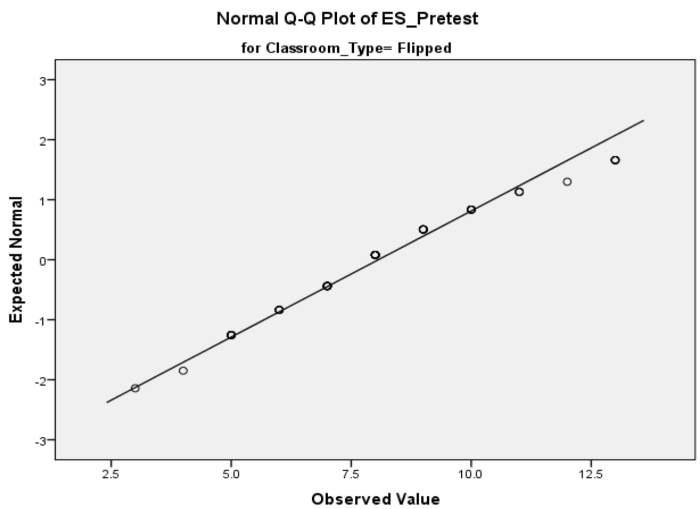


Figure 12. Histograms of distribution of pretest and posttest scores for Endocrine System Unit Test according to class type.



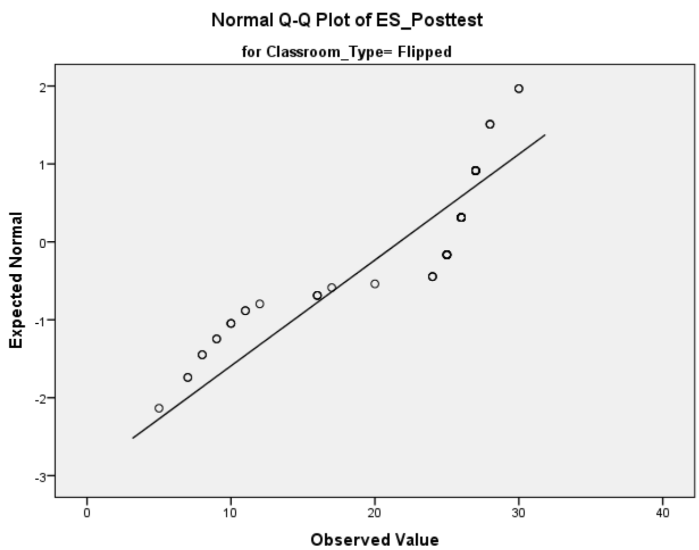
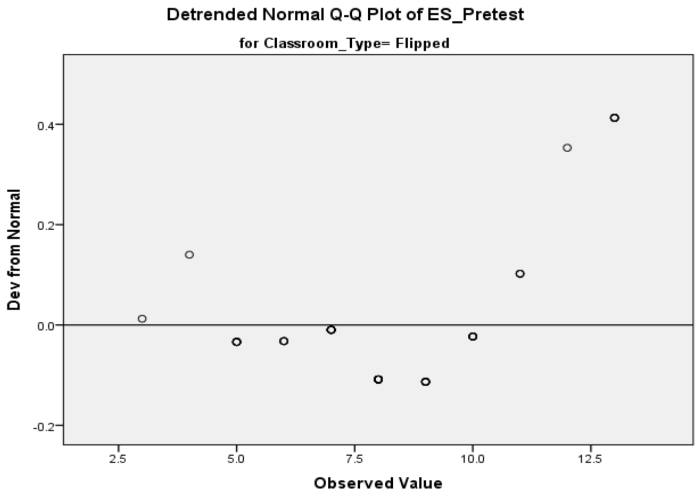


Figure 13. Normal Q-Q plot of Endocrine System Unit Test pretest and posttest scores, flipped class.



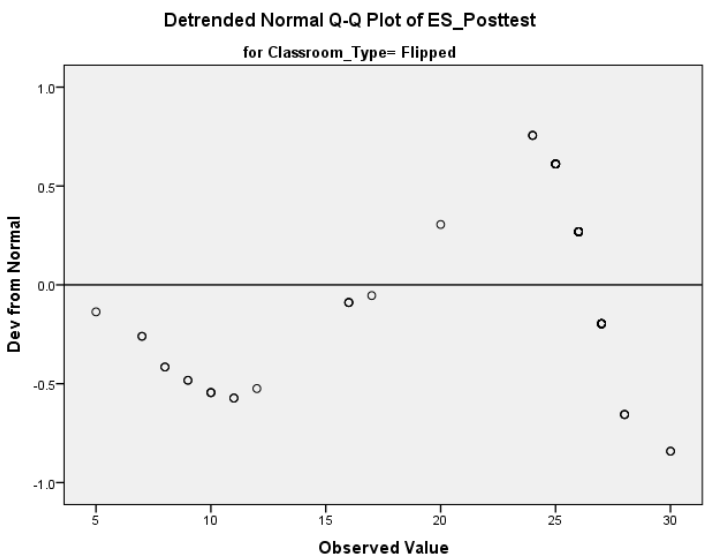
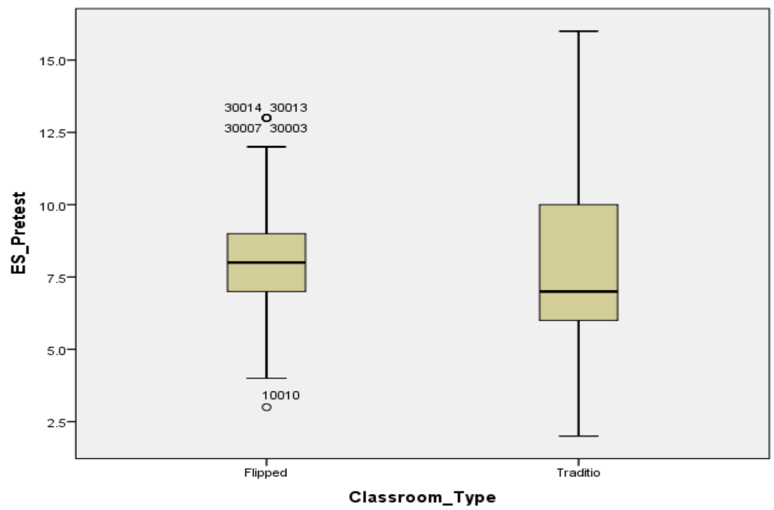


Figure 14. Detrended Normal Q-Q plot of Endocrine System Unit Test pretest and posttest scores, flipped class.

Inspection of boxplots indicated no violation of assumptions of extreme outliers for the endocrine system unit test posttest data; therefore, assumption of no extreme outliers was tenable. Inspection of boxplots indicated violation of assumptions of extreme outliers for the pretest data; assumption of no extreme outliers was not tenable (Figure 13). To determine if outliers should be removed from the data file, the trimmed mean and mean values were observed. The two mean values (8.07 and 8.02) were very similar; therefore, cases were retained in the data file.



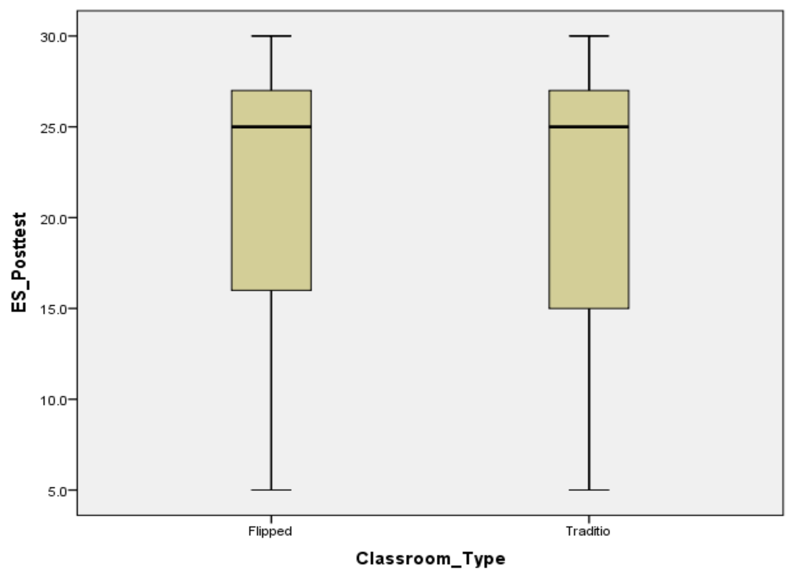


Figure 15. Boxplots for Endocrine System Unit Test pretest and posttest, flipped and traditional classes.

Since the study contained more than 50 participants, results of Kolmogorov-Smirnoff (Tabachnick & Fidell, 2013) were utilized to ensure there was not a violation of assumption of normality for the endocrine system pretest, flipped class setting and traditional class setting (p = .00 which is less than α = .05). However, the mean of any random variable will be approximately normally distributed as sample size increases according to the Central Limit Theorem (CLT) (Stevens, 2009; Tabachnick & Fidell, 2013). Therefore, with a sufficiently large sample size (*n* > 100), deviations from normality will have little effect on the results (Tabachnick & Fidell, 2013).

Table 6

Endocrine System Unit Test tests of normality.

Class Type		Kolmogorov-Smirnov			Shapiro-Wilk		
		Statistic	Df	Sig.	Statistic	Df	Sig.
Endocrine System Unit Test Pretest	Flipped	.150	61	.002	.953	61	.021
	Traditional	.171	62	.000	.953	62	.019
Endocrine System Unit Test Posttest	Flipped	.322	60	.000	.764	60	.000
	Traditional	.272	62	.000	.837	62	.000

Variance. The assumption of homogeneity of variance for the Endocrine System Unit Test data was examined with Levene's Test. Levene's test measures the hypothesis that the variances are equal across the groups (Field, 2005; Rovai et al., 2013). According to Rovai et al. (2013), Levene's test is accepted as robust when deviations from normality are observed. Levene's test for the endocrine system unit test pretest was significant, $F(1, 121) = 4.37$, $p = .04$; thus, the degrees of freedom were adjusted due to unequal variances. After adjusting for unequal variances, assumption of homogeneity of variance was met for endocrine system unit test pretest data, $F(1,107.85) = 3.37$, $p = .07$.

Correlation. The Pearson product moment correlation coefficient, *r*, was calculated to reveal if the dependent variables, academic achievement and motivation were correlated. A correlation measures the relationship between variables; if a significant relationship is found to exist, the two variables are said to covary (Rovai et al., 2013; Warner, 2013). A very weak, negative correlational relationship between the dependent variables, academic achievement and motivation, $r(122) = -.14$, $p > .05$. The coefficient of determination was calculated to determine how much variance the two variables shared, and found to be 1.96% shared variance. A MANOVA examines the interaction between variables, and determines if groups differ on more than one dependent variable (Gall et al., 2007). As a result of the insignificant correlations among the dependent variables, the MANOVA was not conducted. An examination of the scatterplot the further confirmed the weak correlation between the two variables, academic achievement and motivation (see Figure 16).

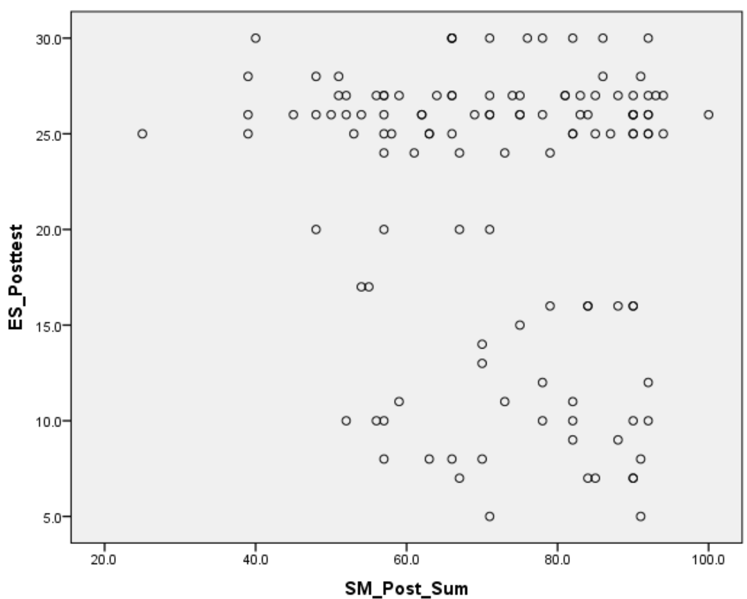


Figure 16. Scatterplot of dependent variables, academic achievement (endocrine system unit test) and motivation (SMQ-II).

Reliability. Reliability testing was conducted to examine the internal consistency of responses to a group of questions. The reliability measure, Cronbach's alpha, for the Endocrine

System Unit Test questions was calculated as 0.93. A Cronbach's alpha of 0.93 indicates excellent reliability (Tabachnick & Fidell, 2013).

Analysis Results. The statistical analysis used to examine the first null hypothesis was an independent *t*-test instead of the between subjects analysis of variance (ANOVA) due to independent variable, classroom type, only having two levels—flipped and traditional. According to Rovai et al. (2013), the between-subjects ANOVA is appropriate when there is a need to compare the means of three or more groups, and the independent *t*-test is used to compare means of two groups. Both analyses are based on similar mathematical models, and "…produce identical *p*-values when two means are compared" (Rovai et al., 2013, p. 296). The analysis of covariance (ANCOVA) was not used because there was no statistically significant difference in endocrine system unit test pretest scores for flipped and traditional class settings.

An independent *t*-test was conducted to compare the endocrine system unit test posttest scores for flipped and traditional class settings. There was no significant difference in posttest scores for flipped class setting (M =21.72, SD = 7.36) and traditional class setting (M = 21.44, SD = 7.82), $t(120) = .2$, $p = .84$. The magnitude of the difference in means (mean difference = .28, 95% CI: -2.44 to 3.01) was very small (eta squared = .00).

Summary

Two hypotheses were examined to assess students' motivation and academic achievement in science according to types of class settings. Mean scores for the endocrine system unit test and the SMQ-II were analyzed using two separate independent *t*-tests. Table 7 shows the results for each analysis and the corresponding hypothesis.

Table 7

Results of Statistical Analysis per Hypothesis

Hypothesis	Rejected	Failed to Reject
H_{01} = There is no statistically significant difference in urban high school students' motivation scores, as measured by the Science Motivation Questionnaire II, when participating in the flipped classroom as compared to students who participate in the traditional classroom.	X	
H_{02} = There is no statistically significant difference in urban high school students' science achievement scores, as measured by the Human Anatomy and Physiology Endocrine System Unit Test, when participating in the flipped classroom as compared to students who participate in the traditional classroom.		X

The results showed that there was a statistically significant difference in the posttest mean scores for the SMQ-II; thus, Null Hypothesis One was rejected. The results showed there was no statistically significant difference in the endocrine system unit posttest scores of urban high school students who participated in the traditional class setting and students who participated in the flipped class setting; thus, Null Hypothesis Two was not rejected.

The results of the research study are important in continuing to understand the effects of the flipped class on students' academic achievement in science provided the inadequate amount of research available in education and, specifically, science education literature. The results are also relevant in assessing the impact the flipped classroom may have on motivation to learn science. In Chapter Five, the results, implications, limitations, and suggestions for future research will be discussed.

CHAPTER FIVE: CONCLUSIONS

Overview

This chapter provides a summation and discussion of the findings of the study. In the proceeding sections results for each research question, along with implications, limitations, and conclusion will be discussed. Lastly, recommendations for future research based on the findings of this study will be presented.

Discussion

The purpose of this quantitative study was to examine the effect of the flipped classroom on urban high school students' motivation and academic achievement in a science course at North Star High School. The sample population consisted of 12th grade African-American students enrolled in intact human anatomy and physiology classes at North Star High School. The instruments used to investigate the possible impact of the flipped classroom on motivation and academic achievement, were the Student Motivation Questionnaire II (SMQ-II) (Glynn et al., 2011) and the endocrine system unit test (Pearson© Education, 2015).

Previous studies found that several factors contributed to the increasing number of underrepresented minorities not entering or leaving STEM fields (Hill et al., 2010; Griffith, 2010). Chen (2013) stated a relationship exists between the decrease in STEM fields, and factors such as motivation, confidence, and achievement. A possible way of resolving the declining numbers of underrepresented minorities in STEM fields may be in the secondary educational system. There are studies that suggest the flipped class learning strategy is a method that helps students improve in academia and the motivation to learn (Enfield 2013; Millard, 2012). This study adds to the current body of literature in science education by examining the impact of the flipped class on high school students' motivation and academic achievement in a science course.

Research Question One

Research question one was as follows: Is there a statistically significant difference in urban high school students' motivation scores, as measured by the Science Motivation Questionnaire II when participating in the flipped classroom as compared to students who participate in the traditional classroom? Motivation is a multifaceted term. For this study, motivation is defined as "internal state that arouses, directs, and sustains science-learning behavior" (Glynn et al., 2011, p. 1160). Analysis of the posttest scores on the Science Motivation Questionnaire II showed the flipped class scored higher than the traditional class indicating an increase in motivation. However, it should be noted that although the results of the independent *t*-test indicated a statistically significant difference in the scores, the magnitude of the difference in means was very small. The very small difference in means suggested the difference in the scores between the flipped and the traditional class settings was not large enough to have practical meaning. As a result of the very small effect size, the results should be interpreted with caution.

The results of this study are supported by research that suggest learning environments, such as the flipped class, are more likely to fulfill students' need to be able to learn and relatedness which leads to an increase in motivation (Abeysekera & Dawson, 2015). Abeysekera and Dawson (2015) suggested students desire to learn and comprehend new content, and learning environments that support the desire contribute to being motivated to be successful in the class. For students to experience an increase in motivation there must be a satisfaction in engagement in learning activities (Abeysekera & Dawson, 2015). Deci and Ryan (2000) suggested motivation will increase with learning activities that students find innovative, challenging, and appealing. Active learning approaches are supported to increase students' level of comfort for solving problems while also increasing comprehension of concepts (Herreid & Schiller, 2013; Kettle, 2013; Zappe, Leicht, Messner, Litzinger, & Lee, 2009).

The increase in motivation with implementation of learning environments like the flipped class is the premise of the self-determination theory (SDT) (Deci & Ryan, 2000). The results of this study support the SDT given that the SMQ-II posttest scores were higher for the flipped class setting than the traditional class setting.

Additionally, previous research showed that students are motivated to learn and participate in learning when hands-on activities and the opportunity to collaborate with students are presented (Bryan et al., 2011). Consequently, studies showed students are less motivated when a tremendous amount of contextual material is presented during traditional face-to-face instruction (Bryan et al., 2011). According to Baeten, Kyndt, Struyven, and Dochy (2010) and Baeten, Struvyen, and Dochy (2013), there may be a correlation between motivation and students' preference for the flipped classroom. For this research study, students participating in the flipped classroom may have experienced this circumstance, and thus demonstrated higher SMQ-II mean scores than students in the traditional classroom.

Research Question Two

Research Question Two was as follows: Is there a statistically significant difference in urban high school students' science achievement scores, as measured by the human anatomy and physiology endocrine system unit test when participating in the flipped classroom as compared to students who participate in the traditional classroom? Academic achievement can be defined on multiple levels, and includes various educational outcomes; thus, academic achievement is contingent on the types of indicators used to measure outcomes (Steinmayr et al., 2015). For this research study, academic achievement is defined as the level of mastery, numeric grade, attained on a high school human anatomy and physiology endocrine system unit test (Pearson© Education, 2015) according to Georgia Performance Standards (Georgia Department of Education, 2006). The study indicates no statistically significant difference existed on the mean posttest scores for the endocrine system unit test between the flipped and traditional classes.

Previous research showed there was an increase in academic achievement after implementation of the flipped classroom (Steinmatz, 2013; Fulton, 2012; Green, 2012). However, the results of the current study, fail to support previous research studies that showed an increase in student academic achievement. The results did, however, add to the current body of literature in science education which showed that the improvement in academic achievement with the flipped class cannot be generalized for all student populations.

Some research demonstrated a correlation between academic achievement and motivation (Akbas & Kan, 2007; Sevinç et al., 2011). Akbas and Kan (2007) showed that as students' motivation increased so did their achievement in the science course. Sevinç et al. (2011), using the Students' Motivation Toward Science Learning scale (Tuan et al., 2005), showed a linear relationship between academic achievement and students' motivation; as achievement increased, students' motivation also increased. The current study contradicts previous research due to the very weak correlation found between academic achievement and motivation among students.

The social cognitive theory (SCT) (Bandura, 1986) was created to show how students need to believe that that a task or activity can be successfully attained, and this in turn will motivate students to be successful in learning. The overall result of the motivation to want to learn will lead to increased academic achievement. The results of this study do not support the social cognitive theory given that there was no significant difference in the endocrine system unit test posttest scores between the flipped and traditional class settings. A summary of the findings is provided in Table 8.

Table 8

Description of Organization of Theoretical Framework, Research Questions, Design, and Data with Outcomes

Research Question	Theoretical Framework	Data Sources	Outcomes	Contribution
RQ1	Self Determination Theory	Science Motivation Questionnaire-II	Increased SMQ-II posttest scores for flipped class setting	Supports Self Determination Theory
RQ2	Social Cognitive Theory	Endocrine System Unit Test	No difference in Endocrine System Unit Test posttest scores between flipped and traditional class settings	Does Not Support Social Cognitive Theory

Conclusion

The purpose of this study is to examine the impact of the flipped classroom on urban high school students' motivation and academic achievement in science. Results indicate there was a statistically significant difference in the motivation of students in the flipped classroom as compared to students in the traditional classroom. Furthermore, the results of this study indicate there was not a statistically significant difference in the academic achievement of students in the flipped classroom as compared to students in the traditional classroom.

Based on these results, the flipped classroom was found to produce an increase in student motivation in comparison to the traditional classroom. These results suggest that the flipped class has positive influence on students' motivation in an urban high school science class. According to Deci and Ryan (1985) and Deci et al. (1991), students are motivated as a result of engagement in activities of interest, intrinsic motivation, or just to complete a required assignment, extrinsic motivation. Although an increase in motivation was observed in students in the flipped class as compared to students in the traditional class, it was not determined as to the reason behind the increase in motivation. Determining the reason for the observed increase in motivation may assist with the future design of instructional planning in science classrooms with establishing and maintaining students' interest in science. However, students' academic achievement was not impacted by the flipped or traditional classroom with implementation of the flipped class suggesting further empirical research is needed to examine the relationship between the instructional strategy and science content mastery in an urban setting.

Previous research studies proposed that a positive correlation exists between motivation and achievement which indicates that when an increase in motivation is observed improvement in academic achievement is also to be observed (Bryan et al., 2011; Khoshnam et al., 2013). The results from this study fail to support Bryan et al. (2011) and Khoshnam et al. (2013) due to the very weak correlation found between the SMQ-II motivation scores, and the endocrine system unit test academic achievement scores.

Glynn et al. (2011) believed positive student engagement (e.g. active participant in class, laboratory experiments or demonstrations, etc.) produced motivated students which in turn would result in improved academic achievement. Implementation of the flipped class includes active participation in class, more hands-on activities such as laboratory investigations or demonstrations, and more frequent teacher feedback on assignments; however, the results of this study contradict those of previous research studies. As such, this researcher proposes that, despite implementation of the flipped class, other variables that have yet to be addressed are influencing students' academic success and motivation in the science class.

The results of this study indicate implementation of the flipped curriculum in secondary science may not produce results implied in current publications. More specifically, previous studies (Enfield, 2013; Steinmatz, 2013; Fulton, 2012) indicated an increase in academic achievement as a result of implementation of the flipped class. Large percentage improvements ranging from 67% to 80% in achievement were found in the studies when the flipped class was used in secondary and first year undergraduate courses (Fulton, 2012; Enfield, 2013; Steinmatz, 2013). Nonetheless, there are variables that need to be taken into consideration such as students' comfort level with technology, students' commitment to completing flipped assignments outside of the classroom, teachers' instructional delivery, accessibility to technology outside of the flipped class, specific motivational reasons for participating in class, and completing assignments. Therefore, further research is recommended to examine how the variables impact students' motivation and academic achievement while enrolled in a flipped class setting.

Implications

With the upcoming implementation of new science Georgia Standards of Excellence (GSE), the state's Department of Education is looking to change science education by incorporating three dimensions—science and engineering practices, cross cutting concepts, and core ideas—to drive instruction and assessment of science courses in grades in K-12 (Georgia Department of Education, 2016). Implementation of the science GSE will allow for deeper comprehension of science by understanding the "how" and "why" of science content to support science achievement and performance (Georgia Department of Education, 2016). Teachers and administrators will have to devise instructional strategies that will meet the needs of students, and also show improvement in science achievement with execution of the new science standards. Although more incorporation of technology into the classroom instruction is proposed, the means in which technology is incorporated may determine whether increases in achievement are found in K-12 science classrooms.

It is predicted that by 2019 approximately 50 percent of the high school courses in the U.S. will be taught online (Georgia Department of Education, 2012). As a result, administrators need teachers to create engaging, effective, and relevant teaching and learning environments (Georgia Department of Education Report, 2012). Due to the push by Georgia's Department of Education to utilize digital online learning resources in science, teachers must find alternate ways to teach the curriculum while also keeping students engaged (Georgia Department of Education, 2013). The flipped classroom is a method that may focus on these concerns by engaging students with the integration of digital online technology to teach the science performance standards as mandated by the state. This study failed to show improvements in academic achievement; however, the results cannot be generalized and may produce different results with a different sample population.

Schools must transform delivery models in order to expand student learning and motivate students to learn science while integrating technology (Georgia Department of Education, 2012). As such, teachers are urged to simultaneously increase students' interest and academic achievement in science fields (Georgia Department of Education, 2013, 2016); therefore, it is important to comprehend the variables that contribute to students' motivation and academic achievement. This study proposed that motivation may be improved with the transformation of the science class by incorporating more digital content delivery and hands on activities, but the study did not determine whether the impact was a result of intrinsic or extrinsic motivation being altered through the implementation of the flipped class. Therefore, the results of the data cannot be used to determine the rationale behind the increase in motivation among students who participated in the flipped class model. Nevertheless, the findings suggest that change of content delivery impacts the motivation students have for learning science.

This research study was based on a hypothesis that the flipped classroom would improve urban high school students' academic achievement in the science class due to the implementation of the flipped classroom. Despite the contradiction with the results of the study to support the hypothesis, the study provided insight for future research on the flipped class in the urban science class. The findings suggest that the flipped classroom may not be a one size fits all instructional learning method that will produce positive results when implemented in any classroom.

Limitations

Student participants who showed a high number of absences either from class or school may have been instructionally impacted by the lack of content material learned and the inability to participate in the activities conducted during class. This could be a limitation, and possible threat to internal validity due to the inability of the researcher to monitor student attendance and the amount of instructional time students received. Students who were present daily in class had the opportunity to obtain the content material delivered by the teachers, and engage in the accompanying activities. However, students who failed to attend class daily did not receive the same amount of instructional time as it relates to content delivery and activities. This could have changed the results of posttest scores on the SMQ-II and endocrine system unit test.

The inability of the researcher to have randomization in the study was a limitation which could become an internal validity threat. Non-randomization of the participants may lead to presence of the selection of threat of validity in the study (Rovai et al., 2013), thus, a pretest to control for non-groups (Campbell & Stanley, 1963) selection threats, history, experimental mortality, and testing (Rovai et al., 2013) was used.

History could be a limitation and present a threat to internal validity for the study as students were not separated according to achievement levels. Students who possessed prior knowledge may have had more of an advantage in mastery of the content as compared to students who did not possess the same knowledge. This was controlled statistically through utilization of the pretest-posttest design for nonequivalent groups to decrease internal validity threats (Gall et al., 2007).

Experimental treatment diffusion is a limitation as the control group may have become aware of the treatment being given to the experimental group, and may have potentially been diffused subconsciously through student participants and teachers (Rovai et al., 2013). One mean of restricting this type of limitation for this study was the usage of the Edmodo™ educational social learning website. Only students enrolled in the flipped classroom had access to the contents on the website using only the individual passcodes distributed to students by the flipped class instructor.

A threat to external validity could arise from students simply being aware of participation in a research study. This limitation and possible threat to external validity is referred to as the Hawthorne Effect in which participants alter behavior due to participation in an experiment or study (McCambridge, Whitton, and Elbourne, 2014). Students were aware of the study as a result of the informational session held with parents and students prior to the beginning of the study, and having to sign permission forms to participate. Therefore, student motivation and academic achievement may have been impacted by the novelty of engaging in a research study, and not due to the implementation of the flipped class.

The SMQ-II survey was a self-reporting instrument students completed before and after content delivery on the endocrine system. Students could have answered the questions based only on previous science class experiences, and not include the current science course. Newell et al. (2015) suggested students' attitudes about science are created prior to entering high school; thus, students' responses to the survey could have been influenced by previous interactions in the science classroom. The responses on the survey could have also been affected by external contributing factors that were not able to be observed prior or during the time of data collection with the study. The responses obtained from students on the SMQ-II, a self-report instrument, were also based on truthfulness from participants. Changes in motivation may not be as a result of participation in the flipped class setting, but instead due to students' reflections on previous experiences in a science course, and responding in fact, truthfully based on those experiences. As a result of not being able to ascertain a difference between the answer responses the researcher has to rely on students responding truthfully when completing the self-reporting survey about the current course.

Generalizability may have been a limitation for this research study (Rovai et al., 2013). The results of this study are not generalizable to other populations or content areas in science. For this study, only African-American students participated as opposed to other underrepresented minorities. Also, the study was in an urban high school setting which may not be indicative of similar educational student populations within the State of Georgia. Nevertheless, this was not the instance, and leads to external threats of validity. Additional studies would need to be conducted to determine generalizability.

As the endocrine system unit test is a measure of achievement of very specific content material, the use of the test could serve as a limitation to this study. Future studies could utilize other measures of science achievement which could yield different results. The content selected for the Endocrine System Unit Test was chosen using a database of questions from the online tool Mastering A&P (Pearson© Education, 2015). The questions selected for this study were chosen based on the relevance of the content covered and alignment to the Georgia Department of Education Science Standards for human anatomy and physiology. Different questions may be selected based on the necessities of a replicated study.

Recommendations for Future Research

Even though numerous studies exist on the flipped class, more research needs to be conducted on aspects of the flipped class in the science class. One such area is implementation of the flipped class in an urban setting. Additional studies need to be conducted using different grade levels and different subject areas in the urban school setting. This will help with the generalizability of this study.

Another suggestion is to conduct a case study or a longitudinal study on the flipped class in a science environment which may help to provide more data on the impact of the instructional method on student achievement. This study took place over a period of four weeks, and may not have allowed enough time to view a difference in achievement between the two classroom settings after implementation of the flipped class. By extending the amount of time for the research study data can be captured at specific time intervals in the study to determine if and when changes are noted in achievement (Lodico et al., 2010).

The social cognitive theory (SCT) (Bandura, 1986) is the basis of one aspect of this study, academic achievement, and is comprised of different concepts including self-regulation, self-efficacy, observation, and outcome expectations. With research indicating a relationship between motivation and achievement, the results of this study contradict previous studies. Therefore, additional research should be conducted looking at two of the SCT concepts—self-efficacy and self-regulation—and their influences on motivation and achievement (Denler et al., 2014). The study could examine the self-regulation theory (SRT) (Bandura, 1991), and how it is used in education to examine achievement and motivation. Zimmerman (2002) suggested the difference in students' learning is based on their varying levels of self-regulation. This is a trait reflective of students wanting to complete an activity for themselves in a proactive manner as opposed to completing the activity only as a result of being taught the content material (Zimmerman, 2002). According to Zimmerman (2008) and Velayutham and Aldridge (2012,) self-regulation is the main element needed to increase students learning science, and further research should be conducted to examine the effects of the learning environment on science learning.

The results of this study show a difference in the posttest scores on the SMQ-II for students in the flipped class as compared to students in the traditional class. However, an explanation for the increase was not able to be determined. To ascertain if students' intrinsic or extrinsic motivation changed, a study could be conducted using the goals content sub-theory (GCT) of the self-determination theory (SDT) (Reeve, 2012). GCT focuses specifically on "what" aspect of intrinsic or extrinsic motivation positively impacts students' achievement. The results from the study could help educators derive instructional strategies and resources beneficial to the success of students in the science class.

Lastly, future studies should be conducted to examine the difference in genders among underrepresented urban high school minorities. Research studies showed a decrease in science interest among females as they matriculated through high school (Desy et al., 2011; Sadler et al., 2012). The studies conducted did not use the same sample population that was used in this study. Instead, Desy et al. (2011) sample population consisted of 1300 students in grades six through twelve enrolled in six different school districts in Minnesota. The population was made up of 87.5% white, 4.3% Hispanic/Latino, and 1.7% American Indian; there was no representation of African-Americans (Desy et al., 2011). Sadler et al. (2012) conducted a longitudinal study comprised of 6000 undergraduate students enrolled in 34 two- and four-year institutions taking an English course. The study by Sadler et al. (2012) failed to discuss the composition of ethnicities represented in the study. However, the data in both studies showed a decrease in science interest among females during matriculation through high school. Although the study conducted by Sadler et al. (2012) was comprised of undergraduate students, reflections were obtained from participants as it related to when participants exhibited a declining interest in science during specific points in their life. The data collected could help with determining if interventions need to be implemented for female urban minorities in lower performing schools prior to entering high school, and to what degree is the difference in motivation observed in both genders. It is also suggested that future research be conducted on additional underrepresented minority populations such as the Hispanic/Latino population due to an existing gap in science achievement (Quinn & Cooc, 2015). The results from the study could potentially determine if the flipped class has an impact on the science achievement of other minority populations, and if the flipped class could assist with finding a way to decrease the achievement gap between other ethnicities.

Science motivation and academic achievement is problematic when attempting to support through continued research (Koballa & Glynn, 2010). Students are said to have increased motivation when engaged in exciting learning experiences. The increased motivation is suggested to also lead to increase academic achievement; hence policymakers should consider students' motivation to learn science when measuring the learning outcomes of science classrooms (Koballa & Glynn, 2010). Therefore, future studies could be conducted on implementing some facet of the flipped class as an additional approach to devising a way to increase student science achievement and motivation if implementation of the full flipped class may be too great for school districts to execute.

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APPENDIX A

Informed Consent Form

CONSENT FORM

The Effect of the Flipped Classroom on Urban High School Students' Motivation and Academic Achievement in a Science Course

Keshia L. Dixon
Liberty University
School of Education

You are invited to be in a research study of the flipped classroom, and student motivation and academic achievement. You were selected as a possible participant because you are a 12th grade student enrolled in human anatomy and physiology. I ask that you read this form and ask any questions you may have before agreeing to be in the study.

Keshia L. Dixon, a doctoral candidate in the School of Education at Liberty University, is conducting this study.

Background Information:

The purpose of the study is to look at the effect of the flipped classroom on urban high school students' motivation and academic achievement while enrolled in a high school science course.

Procedures:

If you agree to participate in the study, you will receive instruction using either the non-flipped (traditional) classroom or the flipped classroom format. The format you will be exposed to will be assigned by the researcher before beginning the study. Participants in the flipped classroom will receive instruction using the educational website, Edmodo™. Students in the non-flipped classroom (traditional) will receive instruction using the traditional teacher-student face-to-face format. Both groups will cover the same content and laboratory experiment in the human anatomy and physiology course.

Risks and Benefits of being in the Study:

No risks will be associated with participation in the study except for those that align with the course, and what the participant would encounter in everyday life.

The benefits to participation are students receiving an alternate instructional method that may increase students' motivation and academic achievement in science.

Compensation:

You will not receive compensation for taking part in this study.

Confidentiality:

The records of this study will be kept private. In any sort of report I might publish, I will not include any information that will make it possible to identify a subject. Research records will be stored securely and only the researcher will have access to the records. For this study, the researcher will store data on a password protected external hard drive accessible only to the researcher. After the study is completed all documents will be shredded associated with the study.

Voluntary Nature of the Study:

Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with Liberty University. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

Contacts and Questions:

The researcher conducting this study is Keshia L. Dixon. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at kdixon51@liberty.edu or (678) 250-4338. You may also contact the research's faculty advisor, Dr. Jillian Wendt, at jarnett@liberty.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd, Carter 134, Lynchburg, VA 24515 or email at irb@liberty.edu.

Please notify the researcher if you would like a copy of this information to keep for your records.

Statement of Consent:

I have read and understood the above information. I have asked questions and have received answers. I consent to participate in the study.

(NOTE: DO NOT AGREE TO PARTICIPATE UNLESS IRB APPROVAL INFORMATION WITH CURRENT DATES HAS BEEN ADDED TO THIS DOCUMENT.)

Signature of minor: ____ Date: _______________

Signature of parent or guardian:__________________________________ Date: _______________

Signature of Investigator: ______________________________________ Date: _______________

APPENDIX B

Permission to Conduct Research Study Letter

January 12, 2016

Department of Research and Evaluation
Atlanta Public Schools
130 Trinity Avenue
Atlanta, Georgia 30303

Dear Department of Research and Evaluation:

As a graduate student in the School of Education at Liberty University, I am conducting research as part of the requirements for an Educational Doctorate (Ed.D.) degree in Curriculum and Instruction. The title of my research project is The Effect of the Flipped Classroom on Urban High School Students' Motivation and Academic Achievement in a High School Science Course, and the purpose of my research is to contribute to the current body of literature on the flipped classroom and STEM education, more specifically science. The study will use the Science Motivation Questionnaire II (SMQ II) as created by Shawn Glynn of the University of Georgia, and a Human Anatomy and Physiology Unit Test with questions generated by Pearson's Mastering A&P Online Tool to measure the variables, motivation and academic achievement.

I am writing to request your permission to conduct my research at Frederick Douglass High School, and the ability contact faculty and staff, and students to invite them to participate in my research study. Potential teacher participants will be asked to meet with me during a science departmental PLC in order to receive information about the study, and the expectations, or requirements, for teachers volunteering to participate in the study. Potential student participants and their parents will meet with me during Senior Contract Night at which time information about the study, expectations from students, and risks involved will be discussed in great detail. All participants will be informed that the data collected in the study will be used to show if the implementation of an evidence-based strategy, flipped classroom, has the potential to increase motivation and achievement in science among urban African-American high school students. The data could also potentially show the connection between motivation, achievement, and students selecting a college major or career in a STEM field. Participants will be presented with informed consent information prior to participating. Taking part in this study is completely voluntary, and participants are welcome to discontinue participation at any time.

Thank you for considering my request. If you choose to grant permission, please provide a signed statement on approved letterhead indicating your approval.

Sincerely,

Keshia L. Dixon, Ed.S.
Liberty University Doctoral Candidate
Email: kdixon51@liberty.edu
Phone: (678) 250-4338

APPENDIX C

Science Motivation Questionnaire (SMQ-II)

Science Motivation Questionnaire II (SMQ-II)

© 2011 Shawn M. Glynn, University of Georgia, USA

In order to better understand what you think and how you feel about your science courses, please respond to each of the following statements from the perspective of "When I am in a science course…"

Statements	Never 0	Rarely 1	Sometimes 2	Often 3	Always 4
01. The science I learn is relevant to my life.					
02. I like to do better than other students on science tests.					
03. Learning science is interesting.					
04. Getting a good science grade is important to me.					
05. I put enough effort into learning science.					
06. I use strategies to learn science well.					
07. Learning science will help me get a good job.					
08. It is important that I get an "A" in science.					
09. I am confident I will do well on science tests.					
10. Knowing science will give me a career advantage.					
11. I spend a lot of time learning science.					
12. Learning science makes my life more meaningful.					
13. Understanding science will benefit me in my career.					
14. I am confident I will do well on science labs and projects.					
15. I believe I can master science knowledge and skills.					
16. I prepare well for science tests and labs.					
17. I am curious about discoveries in science.					
18. I believe I can earn a grade of "A" in science.					
19. I enjoy learning science.					
20. I think about the grade I will get in science.					
21. I am sure I can understand science.					
22. I study hard to learn science.					
23. My career will involve science.					
24. Scoring high on science tests and labs matters to me.					
25. I will use science problem-solving skills in my career.					

Note. The SMQ-II is copyrighted and registered. Go to **http://www.coe.uga.edu/smq/** for permission and directions to use it and its discipline-specific versions such as the Biology Motivation Questionnaire II (BMQ-II), Chemistry Motivation Questionnaire II (CMQ-II), and Physics Motivation Questionnaire II (PMQ-II) in which the words *biology*, *chemistry*, and *physics* are respectively substituted for the word *science*. Versions in other languages are also available.

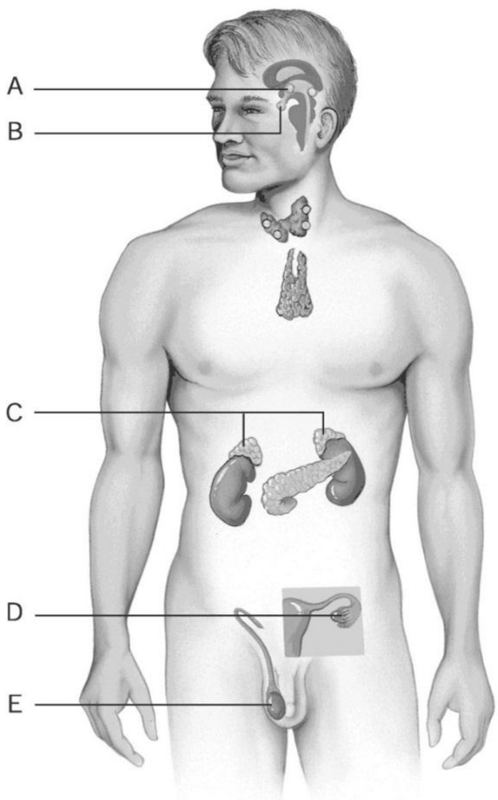
APPENDIX D

Endocrine System Unit Test

Standard: SAP3. Students will assess the integration and coordination of body functions and their dependence on the endocrine and nervous systems to regulate physiological activities.

a. Interpret interactions among hormones, senses, and nerves which make possible the coordination of functions of the body.

Directions: Read all instructions carefully, and be sure to select the most correct answer choice.



Using the figure above, answer the following questions by choosing the letter that best represents the correct answer choice (DOK 1):

1. Produces the hormones that promote the development of the female secondary sexual characteristics at puberty.
2. Storehouse for the hormones produced by the hypothalamus of the brain.
3. Produces the hormones that direct the production of the secondary male sex characteristics.
4. Produce steroid hormones and glucocorticoids and mineralocorticoids.
5. Produces hormones and is considered a neuroendocrine organ.

Select the correct answer choice for each description.

6. Hyposecretion of the pancreas. (DOK 2)

   a. Pituitary dwarfism b. Diabetes mellitus c. Addison's disease d. Acromegaly

7. Hyposecretion of growth hormone. (DOK 2)

   a. Pituitary dwarfism b. Diabetes mellitus c. Addison's disease d. Acromegaly

8. Hypersecretion of growth hormone. (DOK 2)

   a. Pituitary dwarfism b. Diabetes mellitus c. Addison's disease d. Acromegaly

9. The gland that controls the fight or flight reaction. (DOK 2)

   a. Parathyroid b. Adrenal medulla c. Pancreas d. Thyroid

10. Produces hormones that regulate glucose levels in the body. (DOK 2)

    a. Parathyroid b. Adrenal medulla c. Pancreas d. Thyroid

11. Produces a hormone that controls blood levels of calcium and potassium by their removal from bone tissue. (DOK 2)

    a. Parathyroid b. Adrenal medulla c. Pancreas d. Thyroid

12. Produces body's major metabolic hormones. (DOK 2)

    a. Parathyroid b. Adrenal medulla c. Pancreas d. Thyroid

13. Chemical substances secreted by cells into the extracellular fluids that regulate the metabolic function of the other cells in the body are called __________________. (DOK 2)

    a. Enzymes b. Antibodies c. Proteins d. Hormones

14. Oxytocin _____. (DOK 1)

    a. Release is an example of a positive feedback control mechanism.
    b. Is an adenohypophyseal secretion.
    c. Exerts its most important effects during menstruation.
    d. Controls milk production.

15. When it becomes necessary to enlist the fight or flight response, a hormone that is released during the alarm phase of the general adaptation syndrome is ______________. (DOK 2)

    a. Estrogen
    b. Epinephrine
    c. Angiotensinogen
    d. Renin

16. A man has been told that he is *not* synthesizing enough follicle-stimulating hormone (FSH), and for this reason he may be unable to father a child. Choose the correct statement to explain this problem. (DOK 2)

    a. FSH stimulates estrogen secretion by ovarian cells; therefore, it is not synthesized by males.
    b. The physician is wrong—a hormone made in the adenohypophysis could not influence fertility.
    c. FSH stimulates sperm production in the testes.
    d. The man must be producing progesterone, which inhibits the synthesis of FSH.

17. Exocrine glands produce (DOK 2)

    a. Progesterone b. Protein hormones c. Steroid hormones d. No hormones

18. What did the T-score measure in the laboratory investigation? (DOK 2)

    a. Metabolic rate b. Mineral content of bone c. Weight d. Estrogen levels

19. In hypoparathyroidism decreased calcium levels affect function of nerves. What endocrine disease exhibits this affect? (DOK 2)

    a. Acromegaly b. Hyperthyroidism c. Hypothyroidism d. Tetany

20. This links the nervous system to the endocrine system via the pituitary gland. (DOK 2)

    a. Thalamus b. Hypothalamus c. Adrenal d. Pineal

21. This affects wake/sleep patterns and seasonal functions. (DOK 2)

    a. Pineal b. Adrenal c. Thyroid d. Parathyroid

22. If you were to eat four glazed dough nuts, and a large Pepsi which hormone would you expect to be secrete at higher levels? (DOK 3)

    a. Epinephrine b. Insulin c. Growth hormone d. Antidiuretic hormone

23. They are tiny oval glands embedded in the thyroid gland. What gland does this represent? (DOK 2)

   a. Pancreas
   b. Gonads
   c. Parathyroid
   d. Hypothalamus

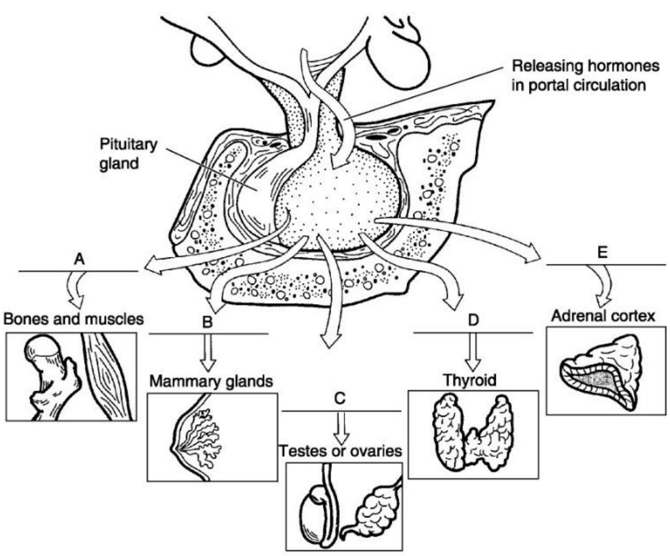
24. The three exocrine pancreatic enzymes are __________________________________. (DOK 1)

   a. Trypsin, steapsin, and amylopsin
   b. Amylopsin, ptyalin, and tryptophan
   c. Steapsin, trypsinogen, and polypeptin
   d. Trypsin, lipase, protease

25. __________ and __________ are hormones from the duodenum that controls the secretions of pancreatic cells. (DOK 1)

   a. Secretin and Pancreozymin
   b. Jejunum and Glucagon
   c. Glucagon and Sodium Bicarbonate
   d. Insulin an Ileum

Match the following hypothalamic hormones with the pituitary hormone targets (DOK 1):



26. Growth hormone-releasing hormone (GHRH)

27. Gonadotropin-releasing hormone (GnRH)

28. Prolactin-releasing hormone (PRH)

29. Corticotropin-releasing hormone (CRH)

30. Thyrotropin-releasing hormone (TRH)

APPENDIX E

Instructional Agenda for Research Study		
Day	**Flipped Classroom**	**Traditional Classroom**
1	**In Class:** **Assignment #1:**Administration of Online Pretests: • Science Motivation Questionnaire II (SMQ-II) (10 minutes) • Endocrine System Unit Test (30 minutes) **Task(s):** Instructor will discuss expectations of the study to students in the flipped setting (i.e. completion of homework and formative assignments, viewing of presentations and videos for notes using Edmodo, need to adhere to deadlines for tasks). Students will obtain log in information for gaining access to Edmodo™. **Homework:** **Assignment #1:** Using Edmodo™ students will view PowerPoint presentation created by researcher on endocrine system, and complete guided notes. **Assignment #2:** After completing notes students will create chart indicating name of organ/gland, location of organ/gland, hormone secreted or produced; and indicate whether endocrine or exocrine gland.	**In Class:** **Assignment #1:**Administration of Online Pretests: • Science Motivation Questionnaire II (SMQ-II) (10 minutes) • Endocrine System Unit Test (30 minutes) **Task(s):** Instructor will discuss expectations of students to students in the traditional setting (i.e. completion of classwork and formative assignments, viewing of presentations and videos for notes while in class, need to adhere to deadlines for tasks including homework) . Students will be informed that access to technology utilized by those in flipped class setting will be available to all students after completing of study. **Homework:** N/A
2	**In Class:** **Warm-Up:** Complete five question reading quiz on notes taken from presentation. (10 minutes); **Guided Practice:** Teacher facilitated question/answer period over notes taken on Edmodo™ to clear up misconceptions about endocrine system. (10 minutes)	**In Class:** **Warm-Up:** Students will be introduced to endocrine system through facilitate discussion about feelings that arise if walking down a street at night and all of sudden a dog appears, and starts to run after them. Students will determine that the feeling to run is a part of the "fight or flight" hormone which is a part of the endocrine system. (5 minutes)

	Independent Practice: Students will complete "4-2-1 Free Write Organizer" activity. (60 minutes) **Homework:** **Assignment #1:** View PowerPoint presentation examining the homeostatic relationship between endocrine system and other systems in the human body. **Assignment #2:** Complete online formative assessment (5 question reading quiz on presentation)	**Lecture:** Instructor will provide lecture on endocrine system while students complete guided notes using PowerPoint presentation created by researcher. (60 minutes) **Guided Practice:** After completion of lecture students and teacher will engage in question/answer session to clear up misconceptions about endocrine system. (10 minutes) **Homework:** Create chart indicating name of organ/gland, location of organ/gland, hormone secreted or produced; and indicate whether endocrine or exocrine gland.
3	**In Class:** **Warm-Up:** Using Edmodo™ students will complete "Endocrine System Assignment Sheet" activity. (10 minutes) **Guided Practice:** Teacher facilitated question/answer period on presentation on Edmodo™ on homeostatic relationships between endocrine system and other systems in the human body. (10 minutes) **Independent Practice:** Students will complete PhysioEd CD-ROM interactive activity on the hormones and organs/glands of the endocrine system (small groups) (65 minutes). **Homework:** **Assignment #1:** Using Edmodo™ students will watch two animated videos (https://www.youtube.com/watch?v=gH8dGK7s6lY running time of 5:41) (https://www.youtube.com/watch?v=HXPCQBD_WGI running time of 5:46) on the endocrine system. **Assignment #2:** Complete assignment "Glands at Work"	**In Class:** **Warm-Up:** Complete five question quiz on notes taken in class during previous class session. (10 minutes) **Review of Homework:** Students will submit and review chart created for homework from previous night. (10 minutes) **Independent Practice:** Students will complete "4-2-1 Free Write Organizer". (60 minutes) **Homework:** Complete the six Short Answer Essay questions at end of endocrine system chapter in textbook.

4	**In Class:** **Warm-Up:** Review "Gland at Work" activity from previous night (10 minutes) **Independent Practice #1:** Students will participate in a modified version of the game "Bingo" in which students will have different player cards, and instructor will read the clues for students to try to cancel out all appropriate vocabulary terms either horizontally, vertically, or diagonally (50 minutes). **Independent Practice #2:** "Windshield Check" formative assessment. Students will state whether their level of comprehension of the endocrine system is "muddy", "foggy", or "clear", and identify area(s) that need more clarification (15 minutes). **Homework:** Review for written formative assessment on endocrine system to be administered during next class session.	**In Class:** **Warm-Up:** Review short answer essay questions completed for homework from previous night. (10 minutes) **Lecture:** Instructor will provide lecture notes on examination of homeostatic relationship between the endocrine system and other systems in the human body. (30 minutes) **Students will rotate between each station for the allotted time in order to complete each assignment**. **Independent Practice#1:** Complete "Endocrine System Assignment Sheet" (hard copy) (15 minutes) **Independent Practice #2:** Complete "Glands at Work" activity (15 minutes) **Independent Practice #3:** "Windshield Check" formative assessment. Students will state whether their level of comprehension of the endocrine system is "muddy", "foggy", or "clear", and identify area(s) that need more clarification (15 minutes). **Homework:** Review for written formative assessment on endocrine system to be administered during next class session.
5	**In Class:** **Warm-Up:** Complete written 10 question formative assessment on the glands and hormones of the endocrine system (15 minutes) **Assignment #2:** In pairs, or individually, students will complete a creative writing assignment in which a rap, poem, story will be created completely explaining the location of all glands, vocabulary terms, and the function of the glands (50	**In Class:** **Warm-Up:** Complete written 10 question formative assessment on the glands and hormones of the endocrine system (15 minutes). **Guided Practice:** Students will watch two animated videos (https://www.youtube.com/watch?v=gH8dGK7s6lY running time of 5:41) (https://www.youtube.com/watch?v=HXPCQBD_WGI running time of 5:46) on the

	minutes). **Homework:** N/A	endocrine system. **Independent Practice:** Students will complete PhysioEd CD-ROM interactive activity on the hormones and organs/glands of the endocrine system (small groups) (60 minutes). **Homework:** N/A
6	**In Class:** **Warm-Up:** Review results of written ten question assessment from previous class session. (10 minutes) **Guided Practice:** Engage in facilitated discussion on diseases/disorders on the endocrine system. (10 minutes) **Independent Practice:** Conduct research on diseases/disorders of the endocrine system (students will travel to media center) (60 minutes). **Homework:** Create chart listing: • The disease/disorder • Endocrine gland affected • Population affected • Does hypo or hypersecretion of hormone occur • Symptoms.	**In Class:** **Warm-Up:** Review results of written ten question assessment from previous class session. (10 minutes) **Assignment #1:** Students will participate in a modified version of the game "Bingo" in which students will have different player cards, and instructor will read the clues for students to try to cancel out all appropriate vocabulary terms either horizontally, vertically, or diagonally (50 minutes) **Assignment #3:** In pairs, or individually, students will complete a creative writing assignment in which a rap, poem, story will be created completely explaining the location of all glands, vocabulary terms, and the function of the glands (20 minutes). **Time will be spent with students selecting their partner (if applicable), and coming up with an outline of the creative writing assignment** **Homework:** Students will finish creative writing assignment, and prepare to submit the next class session.
7	**In Class**: **Warm-Up:** Review diseases/disorders of the endocrine system based on chart created by students for homework. (10 minutes)	**In Class:** **Warm-Up:** Review creative writing assignments completed for homework. (10 minutes) **Guided Practice:** Engage in facilitated

	Independent Practice: Complete "Endocrine System Case Studies". Students will be given eight case studies, and using the internet, research the case studies to identify the endocrine disorder, main hormone(s) involved, and the endocrine organ(s) responsible for releasing this hormone (Small Groups--70 minutes). **Homework:** Using Edmodo™ students will complete Lesson 22.2 to determine whether statements about the endocrine system are true or false.	discussion on diseases/disorders on the endocrine system. (10 minutes) **Independent Practice:** Conduct research on diseases/disorders of the endocrine system (students will travel to media center) (60 minutes). **Homework:** Create chart listing: • The disease/disorder • Endocrine gland affected • Population affected • Does hypo or hypersecretion of hormone occur • Symptoms
8	**In Class:** **Warm-Up:** Review Lesson 22.2 homework assignment from previous night. (5 minutes) **Independent Practice:** Students will complete Computer Simulations/Virtual Lab investigations on the Endocrine System. (Students will be paired) (80 minutes) Day 1: • Activity 1: Determining Baseline Metabolic Rates • Activity 2: Determining the Effect of Thyroxine on Metabolic Rate **Virtual lab investigation involves seven different activities. Two activities will be completed over the course of the next three class sessions** **Homework:** N/A	**In Class**: **Warm-Up:** Review diseases/disorders of the endocrine system based on chart created by students for homework. (10 minutes) **Independent Practice:** Complete "Endocrine System Case Studies". Students will be given eight case studies, and using the internet, research the case studies to identify the endocrine disorder, main hormone(s) involved, and the endocrine organ(s) responsible for releasing this hormone (Small Groups--70 minutes). **Homework:** Complete Lesson 22.2 to determine whether statements about the endocrine system are true or false (hard copy).
9	**In Class:** **Independent Practice:** Students will complete Computer Simulations/Virtual Lab investigations on the Endocrine System. (Students will be paired) (85 minutes)	**In Class:** **Warm-Up:** Review Lesson 22.2 homework assignment from previous night. **Independent Practice:** Students will complete Computer Simulations/Virtual Lab

	Day 2: • Activity 3: Determining the Effect of Thyroid Stimulating Hormone (TSH) on Metabolic Rate • Activity 4: Determining the Effect Propylthiouracil on Metabolic Rate	investigations on the Endocrine System. (Students will be paired) (80 minutes) Day 1: • Activity 1: Determining Baseline Metabolic Rates • Activity 2: Determining the Effect of Thyroxine on Metabolic Rate **Virtual lab investigation involves seven different activities. Two activities will be completed over the course of the next three class sessions** **Homework:** N/A
10	**In Class:** **Independent Practice:** Students will complete Computer Simulations/Virtual Lab investigations on the Endocrine System. (Students will be paired) (85 minutes) Day 3: • Activity 5: Hormone Replacement Therapy • Activity 6: Obtaining a Glucose Standard Curve • Activity 7: Comparing Glucose Levels Before and After Insulin Injection **Homework:** Using Edomodo™ complete 10 question formative assessment on activities completed in the virtual lab investigation.	**In Class:** **Independent Practice:** Students will complete Computer Simulations/Virtual Lab investigations on the Endocrine System. (Students will be paired) (85 minutes) Day 2: • Activity 3: Determining the Effect of Thyroid Stimulating Hormone (TSH) on Metabolic Rate • Activity 4: Determining the Effect Propylthiouracil on Metabolic Rate
11	**In Class:** **Warm-Up:** Review results from online assessment completed from Day 10. (5 minutes) **Independent Practice:** Complete lab investigation write-up from Virtual Lab simulation (80 minutes)	**In Class:** **Independent Practice:** Students will complete Computer Simulations/Virtual Lab investigations on the Endocrine System. (Students will be paired) (85 minutes) Day 3: • Activity 5: Hormone Replacement Therapy

	Homework: N/A	• Activity 6: Obtaining a Glucose Standard Curve • Activity 7: Comparing Glucose Levels Before and After Insulin Injection
12	**In Class:** **Warm-Up:** **Independent Practice:** By accessing Edmodo™ students will use a link to access educational website: www.usatestprep.comin order to assist with preparation for online Endocrine System Unit Test. **Homework:** N/A	**In Class:** **Warm-Up:** Complete 10 question written formative assessment on activities completed in the virtual lab investigation. (10 minutes) **Independent practice:** Complete lab investigation write-up from Virtual Lab simulation. (75 minutes) **Homework:** N/A
13	**In Class:** **Guided/Independent Practice:** "Word on the Street". In small groups students will come up with a talk show topic to be discussed in class that surrounds the endocrine system that will be shared with classmates that last 30 minutes of class. (80 minutes)	**In Class:** **Guided/Independent Practice:** "Word on the Street". In small groups students will come up with a talk show topic to be discussed in class that surrounds the endocrine system that will be shared with classmates that last 30 minutes of class. (80 minutes)
14	**In Class:** **Guided/Independent Practice:** Students will participate in an extensive review session with instructor in preparation for online Endocrine System Unit Test. The ActivExpression devices (clickers) will be used by students to record their respective answer choices to review questions prepared by the researcher for use on the Promethean Board©. (75 minutes)	**In Class:** **Guided/Independent Practice:** Students will participate in an extensive review session with instructor in preparation for online Endocrine System Unit Test. The ActivExpression devices (clickers) will be used by students to record their respective answer choices to review questions prepared by the researcher for use on the Promethean Board©. (75 minutes)
15	**In Class:** **Independent Practice:** Administration of Online Posttests: • Science Motivation Questionnaire II (SMQ-II) (10 minutes) • Endocrine System Unit Test (60 minutes) **Task(s):** Instructor will inform students	**In Class:** **Independent Practice:** Administration of Online Posttests: • Science Motivation Questionnaire II (SMQ-II) (10 minutes) • Endocrine System Unit Test (60 minutes) **Task(s):** Instructor will inform students

	that this is the conclusion of the research study, and the class will return to the instructional agenda that was in place before the beginning of the study.	that this is the conclusion of the research study, and the class will return to the instructional agenda that was in place before the beginning of the study. Participants in the traditional setting will be given codes to gain access to technology utilized by the flipped class participants.

APPENDIX F

Permission to Use Mini-Theories of Self-Determination Figure

RE: Permission to Use MiniTheories of Self-Determination Figure
JR
Johnmarshall Reeve < >
Reply all |
Tue 6/23/2015 10:40 AM
To:

...

Tue 6/23/2015 10:40 AM
To help protect your privacy, some content in this message has been blocked. To re-enable the blocked features, click here.
To always show content from this sender, click here.
You forwarded this message on 6/23/2015 3:22 PM

Hi Keshia Dixon,

Yes, you have my permission to use the "mini-theories" figure from the chapter in the Engagement Handbook. I apologize for taking so long to grant this permission, but yes you do have my permission to reproduce the figure.

Good luck in your research!

Johnmarshall Reeve

존 마샬 리브

Johnmarshall Reeve, Professor
XXX Uncho-Useon Hall
Department of Education
Korea University
Anam-Dong, Seongbuk-Gu
Seoul XXX, Korea

----------------------원본 메세지----------------------
From: "Dixon, Keshia "<kdixon51@liberty.edu>
To: "" < >
Cc: "Wendt, Jillian Leigh"
Sent: 2015-06-23 01:50:01 GMT +0900 (ROK)
Subject: Permission to Use MiniTheories of Self-Determination Figure

Good afternoon Dr. Reeve,

My name is Keshia Dixon, and I'm a doctoral candidate at Liberty University where my dissertation chair is Dr. Jillian Wendt. I am following up with you in regards to the email below that was sent in an attempt to obtain permission to use one of the figures from your article entitled, "A Self-Determination Theory Perspective on Student Engagement". I hope that you grant me permission to use it, as it will assuredly be a valuable asset for my literature review and study.

Thank you again for taking time to consider my request, and I look forward to hearing from you in the near future.

Respectively,

Keshia Dixon
Doctoral Candidate, Liberty University

From: Dixon, Keshia
Sent: Tuesday, June 9, 2015 9:05 PM
To:
Cc: Wendt, Jillian Leigh
Subject: Permission to Use MiniTheories of Self-Determination Figure

Greetings Dr. Reeve,

My name is Keshia Dixon, and I am currently a doctoral student at Liberty University in Lynchburg, VA where my dissertation chair is Dr. Jillian Wendt. I have decided to conduct a study examining the effects of the flipped classroom on urban students' motivation and academic achievement in a high school science course, and am building my research on the foundations of the self-determination and social cognitive theories. My purpose for contacting you is to seek permission to use a figure you created (Fig 7.2) summarizing the five mini theories of the self-determination theory. I located this figure while reading your work entitled, "A Self-Determination Theory Perspective on Student Engagement", and felt that the figure gave great visualization and summation of the theory. If granted permission I would of course ensure proper citation is done identifying you as the author.

I thank you in advance for your time and consideration in this matter, and eagerly await to communicate with you in the near future.

Warmly,

Keshia L. Dixon
Doctoral Candidate for the School of Education at Liberty University

APPENDIX G

Permission to Use Promoting Students Interest and Motivation to Learn Science Figure

Re: Permission to Use Figure in Doctoral Research Study
Delete Reply Reply all Forward
Mark as unread
AL
Anni Loukomies < >
Mon 6/22/2015 1:45 PM

You replied on 6/22/2015 2:46 PM.

Dear Keshia,

sorry for the delayed response. We have summer holidays at the moment in Finland and in my summer house I have a very poor internet connection. I try to read the emails from my phone, but all the steps take several minutes and probably I have given it up when trying to answer your mail the first time.

Of course you can use our picture, I'm grad you found it interesting and useful. When you have completed your thesis, it would be nice to have a link in which I could find it.

I wish you all the best luck with the process.

Best regards, Anni

Lainaus "Dixon, Keshia" <kdixon51@liberty.edu>:

> Good afternoon Dr. Loukomies,
>
> My name is Keshia Dixon, and I'm a doctoral candidate at Liberty University where my dissertation chair is Dr. Jillian Wendt. I am following up with you in regards to the email below that was sent in an attempt to obtain permission to use one of the figures from your article entitled, "Promoting Students' Interest and Motivation Towards Science Learning".
>
> I hope that you grant me permission to use it, as it will assuredly be a valuable asset for my literature review and study.
>
> Thank you again for taking time to consider my request, and I look forward to hearing from you in the near future.
>
> Respectively,
> Keshia Dixon
> (678)381-4110
> Doctoral Candidate, Liberty University
>

> From: Dixon, Keshia
> Sent: Tuesday, June 9, 2015 9:18 PM
> To:
> Cc: Wendt, Jillian Leigh
> Subject: Permission to Use Figure in Doctoral Research Study
> Greetings Dr. Loukomies,
>

> My name is Keshia Dixon, and I am currently a doctoral student at Liberty University in Lynchburg, VA where my dissertation chair is Dr. Jillian Wendt. I have decided to conduct a study examining the effects of the flipped classroom on urban students' motivation and academic achievement in a high school science course. My purpose for contacting you is to seek permission to use a figure you created (Fig 1) discussing motivation in the science context, and refining the implementation process. I located this figure while reading your work entitled, "Promoting Students' Interest and Motivation Towards Science Learning: The Role of Personal Needs and Motivation Orientation", and felt that the figure gave great visualization and summation of the process. If granted permission I would of course ensure proper citation is done identifying you as the author.
>
> I thank you in advance for your time and consideration in this matter, and eagerly await to communicate with you in the near future.
>
> Warmly,
> Keshia L. Dixon
> Doctoral Candidate for the School of Education at Liberty University

Anni Loukomies
Lecturer, PhD, MEd
Viikki Teacher Training School
P.O. Box XX (XXXXXX)
FIN-00014 University of Helsinki
Finland
+

APPENDIX H

Permission to Use Science Motivation Questionnaire II

The SMQ-II assesses components of students' motivation to learn science in college and high school courses.

Permission and Directions: Science educators who wish to use the Science Motivation Questionnaire II © 2011 Shawn M. Glynn for research and teaching have permission to do so if they cite the Glynn et al. (2011) reference below and comply with the fair use of this copyrighted and registered questionnaire. This permission extends to discipline-specific SMQ-II versions such as the Biology Motivation Questionnaire II (BMQ-II), Chemistry Motivation Questionnaire II (CMQ-II), and Physics Motivation Questionnaire II (PMQ-II) in which the words biology, chemistry, and physics are respectively substituted for the word science. In any use of the SMQ-II, its versions, and translations to other languages, permission is contingent upon citing the Glynn et al. (2011) reference, which provides information on the SMQ-II administration, components (scales), scoring, reliability, and validity.

Science educators also have permission to:

1. Reproduce the SMQ-II, its versions, and its translations—for fair use in research and teaching, in part or in whole; in print, online, or other media—if they clearly include the copyright notice "Science Motivation Questionnaire II © 2011 Shawn M. Glynn" with the reproduction and

2. Adapt the items of the SMQ-II, its versions, and its translation if they acknowledge the items are "adapted from the Science Motivation Questionnaire II © 2011 Shawn M. Glynn."

Science educators also have permission to use the earlier Science Motivation Questionnaire © 2006 Shawn M. Glynn & Thomas R. Koballa, Jr. if they cite the Glynn & Koballa (2006) and Glynn et al. (2009) references below. The SMQ permission and directions are otherwise similar to those described above for the SMQ-II.

APPENDIX I

Script to be Read by Instructors to Students During Administration of Online Tests

Good morning/Good afternoon students,

You have agreed to participate in a research study for the next three weeks in your human anatomy and physiology class. As part of the research study you will complete two online assessments—the Science Motivation Questionnaire II and the Human Anatomy and Physiology Endocrine System Unit Test. The Science Motivation Questionnaire II is a 25 question multiple choice survey that measures your motivation to learn science. The Human Anatomy and Physiology Endocrine System Unit Test is a 30 question multiple choice assessment that will measure your level of mastery on the endocrine system. Although your participation in the study or your grade on the unit test will **NOT** have a direct impact on your overall grade in the class the researcher asks that you please respond to all questions on the Science Motivation Questionnaire II and the Human Anatomy and Physiology Endocrine System Unit Test honestly and to best of your ability.

Are there any questions? Is there anyone who chooses not to participate at this point in the study?

> ****If there are students who choose not to proceed forward in the study please allow them to leave the testing area, and record the student number(s) for the researcher so that their data can be withdrawn from the study****

If there no questions and all participants remain then proceed as follows:

You will first complete the Science Motivation Questionnaire II…each participant will be given 10 minutes to complete the 25 questions listed on the survey.

1. Please enter the website listed on the paper at your computer.

2. Once you have the survey on the screen in front of you please proceed with completing the questions. Remember you are **NOT** to enter your name or any other identifiable information as your answer responses will remain anonymous. The researcher will **NOT** have access to the database to obtain any identifiable information from your student identification numbers.

3. If you complete the survey before time is called please raise your hand and I will come to you to with further instructions.

After the 10 minutes…

You will now complete the Human Anatomy and Physiology Endocrine System Unit Test…each participant will be given 60 minutes to complete the 30 questions on the assessment.

1. Please enter the website listed on the paper at your computer for entry into the assessment.

2. Once you have the assessment on the screen in front of you please proceed with completing the assessment. Remember you are **NOT** to enter your name or any other identifiable information as your answer responses will remain anonymous. The researcher will **NOT** have access to the database to obtain any identifiable information from your student identification numbers.

3. If you complete the assessment before time is called please raise your hand and I will come to you to with further instructions.

After 60 minutes…

Thank you for your participation in completing the Science Motivation Questionnaire II and Human Anatomy and Physiology Endocrine System Unit Test. Make sure you have not left any identifiable information around your computer area, and please log completely off of your computer. We will now travel back to the classroom for further instructions regarding the remainder of the research study. You are now free to leave the testing area.

APPENDIX J

Permission to Reproduce Promoting Students' Interest and Motivation to Learn Science Figure

Dear Keshia,

congratulations for completing your research! What you suggested is ok with me. Looking forward to seeing your study!

Best, Anni

Anni Loukomies
Lecturer, PhD, MEd
Viikki Teacher Training School
P.O. Box XX (Kevätkatu XX)
FIN-XXXX University of Helsinki
Finland

Lähettäjä: Dixon, Keshia <kdixon51@liberty.edu>
Lähetetty: 19. helmikuuta 2017 22:37:13
Vastaanottaja: Loukomies, Anni M
Aihe: Re: Permission to Use Figure in Doctoral Research Study

Dr. Loukomies,

Greetings...I'm not sure if you remember, but I contacted you about a year and a half ago regarding the use of your figure in your article, "Promoting Students' Interest and Motivation Towards Science Learning". I am finished with my research, and have successfully completed my dissertation defense . Thank you again for allowing me to use the figure, and now wanted to know if it is okay for the figure to be reproduced in my dissertation using my school's, Liberty University, electronic platform, Digital Commons? This is our database where master's theses and doctoral dissertations are uploaded. Before my dissertation can be uploaded, and a link sent to you so that you can view my finished product, I have to receive permission to reproduce the figure in my manuscript so as to not violate copyright infringement.

I look forward to communicating with you soon.

Best,
Dr. Keshia L. Dixon