The Impact of Project Lead the Way Launch Implementation on Elementary Student Self-Concept, Values/Importance, and Interest

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Abstract

The purpose of this study was to determine if fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology were different after the implementation of Project Lead the Way (PLTW) Launch. An additional purpose of the study was to determine if the change in fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology was affected by gender or the selected STEM units taught. Fifth grade students from two elementary schools in the Center School District were administered a survey before and after the implementation of PLTW Launch.

The results of the data analysis revealed that fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology was largely unchanged after PLTW Launch implementation. Additional analysis determined that the change in fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology after PLTW Launch implementation was also largely unaffected by gender and the selected STEM units taught. Of the 27 hypotheses tested, only three hypotheses were supported by the data. First, self-concept of science was significantly different after PLTW Launch implementation. Second, self-concept of science was affected by gender. Lastly, self-concept of mathematics was affected by the selected STEM units taught.

Due to the weak results of this study and the study lasting only one year, school leaders should not rely solely on this study to determine if PLTW Launch is their program of choice to improve student attitudes toward mathematics, science, and technology. Additionally, school leaders should use caution when considering PLTW

Launch as the program of choice to increase female students' attitudes toward mathematics, science, and technology. School leaders should feel confident that making curricular changes to PLTW Launch to match state standards would not have adverse effects on student attitudes. While professional development was not a variable in this study, due to the weak results, school leaders should provide extensive professional development when implementing PLTW Launch.

Recommendations for further research are to include a larger sample of students from multiple elementary grades. Additionally, future research should utilize a mixed methods design to include interviews with students and teachers. Future research should also include achievement data to allow the researcher to make comparisons with the current literature that is mostly achievement centered. Lastly, future research should include an equivalent control group allowing the researcher to compare students' attitudes after PLTW Launch implementation with students who did not experience PLTW Launch.

Dedication

This work is dedicated to my parents, Terry and Sue Shannon. They have sacrificed much to ensure my sister and I have had opportunities they were not afforded. They continue to model unconditional love in its truest form.

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Chapter One

Introduction

In 2005, 15 leading business groups organized a joint effort to ensure the United States remained superior in scientific and technology advancements. The group established a clear and common goal "to double the number of science, technology, engineering and mathematics graduates with bachelor's degrees by 2015" (Business Roundtable, 2005, p. 1). Two years later in 2007, The Business Higher Education Forum, one of the original 15 business organizations, released a comprehensive report outlining specific strategies to reach their goal. The roles and strategies produced by the Business Higher Education Forum (2007) focused on the three components of teacher recruitment, retention, and renewal.

The Business Higher Education Forum (2007) report failed to provide student strategies, specifically ways to create positive student attitudes toward mathematics and science. This lack of student interest led to South Korea graduating as many engineers as the United States and China graduating four times as many engineers as the United States (Business Roundtable, 2005). The statistics are even lower for women and minorities in the United States. In 2012, women achieved 18% of all earned engineering degrees, while minorities accounted for only 13% (Hrabowski, 2015). Something more than focusing on recruiting, developing, and retaining highly qualified mathematics and science teachers is necessary if the U.S. plans "to double the number of science, technology, engineering, and mathematics" (STEM) degrees (Business Roundtable, 2005, p. 1).

In 2010, President Obama's Council of Advisors on Science and Technology (PCAST) released a report that not only addressed teacher shortages in mathematics and science fields, but also included recommendations to improve student attitudes in mathematics and science (Executive Office of the President, 2010). In the report, PCAST stated that there was a need to develop "STEM-related experiences that excite and interest students of all backgrounds" and "support states and school districts in their efforts to transform schools into vibrant STEM learning environments" (Executive Office of the President, 2010, p. iii). PCAST released an additional report in 2012 outlining a strategy that would increase STEM-related degrees by one million over the course of 10 years (Executive Office of the President, 2012).

While efforts have been made to improve STEM education in the United States, recent data suggested overall STEM education has remained stagnant (Kennedy & Odell, 2014). Project Lead the Way, Inc. (PLTW, 2014b), a 501(c)(3) nonprofit STEM organization, developed their first high school engineering program in 1997. PLTW has since grown, expanding to all 50 states and providing programs for students in kindergarten through 12th grade. PLTW's (2013) most recent program, PLTW Launch, was developed in 2013 and first implemented in 2014 for students in elementary school. The Launch program was PLTW's first attempt at writing curriculum for elementary students. Due to the recent inception of PLTW Launch, little research has been conducted showing program effectiveness related to student achievement and the change in student perceptions of self-concept, value/importance, and interest in the STEM fields after exposure to PLTW Launch.

Background

This study was conducted in the Center School District, a small urban district located in Kansas City, Missouri. In 2015, the Center School District had an approximate enrollment of 2,400 PK-12 students. The district reported 74.4% of their students received free or reduced lunch. The student body was primarily minority with 63.5% Black, 19.1% White, 9.2% Hispanic, 6.4% Multiracial, 1.6% Asian, 0.1% Indian, and 0.1% Pacific Islander (Department of Elementary and Secondary Education, 2015b). In 2015, the Center School District was comprised of one early childhood school, four elementary schools, one middle school, one high school, and one alternative middle and high school (Department of Elementary and Secondary Education, 2015a). This study was conducted with fifth grade students in two of the four elementary schools, Center Elementary and Red Bridge Elementary. The other elementary schools were not included in this study because the leadership of the school chose not to implement PLTW Launch or decided to implement PLTW Launch in third grade. Table 1 contains the demographic information for Center Elementary and Red Bridge Elementary.

Table 1

2015 School Demographics

	Center Elementary	Red Bridge Elementary
Total Enrollment	330	252
Ethnicity		
Asian	0.3%	1.6%
Black	82.7%	27.8%
Hispanic	3.0%	15.5%
Multiracial	6.1%	6.3%
Pacific Islander	0.3%	0.4%
White	7.6%	48.4%
SES Status		
Free/Reduced	94.0%	43.0%
Full Pay	6.0%	57.0%

Note. Demographic information for Center Elementary and Red Bridge Elementary contained in Table 1 was retrieved from Missouri Department of Elementary and Secondary Education (Department of Elementary and Secondary Education, 2015a).

In the spring of 2015, Project Lead the Way, Inc. offered districts in the Kansas City metropolitan area grant opportunities to implement newly designed PLTW elementary curriculum. The leadership of Center School District applied for the grant, and the district was awarded $12,000 to implement PLTW. The district decided to implement PLTW in three of its elementary schools: Bonne Elementary, Center Elementary, and Red Bridge Elementary. Center Elementary and Red Bridge Elementary used the allotted funds to purchase fifth grade resources while Boone Elementary purchased resources for third grade. Remaining funds were used to train personnel.

PLTW (PLTW, 2014d) offers five programs with the first program, PLTW Launch, starting in elementary school. PLTW (2014i) Launch is designed for students in kindergarten through fifth grade. Along with building STEM knowledge and applying STEM skills, PLTW (2014i) Launch is designed to be an engaging curriculum that builds confidence in young learners and grows their interest in the STEM field. The designers of PLTW (2014i) Launch created the K-5 program as a flexible and customizable curriculum.

> PLTW Launch curriculum includes 24 modules aligned to grade-level standards. The 10-hour modules are presented in pairs that combine to create a thematic unit. Teachers and schools have the flexibility to introduce the modules that they want, when they want, at the grade level they want. (PLTW, 2014j, para. 3)

The Center School District and the two elementary schools that participated in the study chose to implement PLTW Launch using two implementation methods. Center Elementary chose to use teacher discretion and implement a combination of modules that were designed for third and fifth grade students. The third grade modules implemented were (1) Stability and Motion: Science and Flight and (2) Stability and Motion: Forces and Interaction. The fifth grade modules implemented were (1) Robotics and Automation and (2) Robotics and Automation: Challenge (S. Rose, personal communication, May 3, 2016). Red Bridge Elementary chose to implement the PLTW Launch fifth grade recommended modules. Those four modules were (1) Robotics and Automation, (2) Robotics and Automation: Challenge, (3) Infection: Detection, and (4)

Infection: Modeling and Simulation (M. Fritz, personal communication, May 3, 2016). Center Elementary and Red Bridge Elementary implemented two modules that were the same (1) Robotics and Automation, (2) Robotics and Automation: Challenge (see Appendix A for a detailed description of the modules implemented).

Statement of the Problem

The Business Higher Education Forum (2007) concluded, “American students today have limited interest in studying mathematics and science, and academic achievement in these two foundational disciplines is demonstrably low” (p. 4). Concerns remained in 2013 when the National Center for Education Statistics (2013) reported that only 2-3% of college students entered a mathematics field. Of the students pursuing a STEM field, only 40% graduated with an actual degree in a STEM field (Feder, 2012).

The problems appear to be exacerbated between males and females. “At the higher education level, only 18.5% of bachelor’s degrees in engineering went to women in 2008” (Gonzalez & Kuenzi, 2012, p. 12). In 2010, the President’s Council of Advisors on Science and Technology stated, “women are seriously underrepresented in many STEM fields” (Executive Office of the President, 2010 p. 3). Furthermore, the authors of the report suggested that there was not only a STEM aptitude gap but also a STEM interest gap as females were far less likely to choose STEM majors in college (Executive Office of the President, 2010).

Simply stated, students in the United States are not interested in STEM careers (National Center for Education Statistics, 2013; Feder, 2012; Business Higher Education Forum, 2007; Business Roundtable, 2005). STEM interest appears to be even less amongst female students (Gonzalez & Kuenzi, 2012; Executive Office of the President, 2010). With the known relationship between self-concept, value/importance, and interest, it is important to determine if STEM programs, such as PLTW Launch, change students' self-concept, how valuable and important they believe STEM to be, and their interest level in STEM subjects and STEM careers (Eccels & Wigfield, 2002; Wigfield & Eccles, 1983; Uguroglu & Walberg, 1979).

Proponents of PLTW (2014b) claim students who participate in PLTW in high school have more favorable attitudes toward STEM careers than students who do not participate in PLTW. Due to the recent creation of PLTW (2013) Launch, Project Lead the Way, Inc. does not have data to support program effectiveness at the elementary school level. Therefore, researchers were unsure if the PLTW Launch program had the same positive effects on student attitudes that the PLTW high school programs have. The leadership of Center School District shared this same concern. Furthermore, the leadership of the district was concerned whether the change in self-concept, value/importance, and interest in mathematics, science, and technology were significantly different between genders after the implementation of PLTW Launch. Lastly, district leadership was unsure whether the modules selected for the fifth grade would affect student perceptions of self-concept, value/importance, and interest in the STEM fields.

Purpose of the Study

The first purpose of this study was to determine if there was a difference in fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology before and after implementation of PLTW Launch. The second purpose of this study was to determine whether there was a difference in fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology before and after implementation of PLTW Launch between genders. The third purpose of this study was to determine whether there was a difference in fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology before and after implementation of PLTW Launch between the students who were taught the PLTW recommended curriculum and those who were taught modules using teacher discretion.

Significance of the Study

With PLTW Launch curriculum being relatively new, there was no research supporting its effectiveness, especially in the area of increasing self-concept, value/importance, and interest in mathematics, science, and technology. This study contributed to the research on the impact PLTW Launch has on students' self-concept, value/importance, and interest in mathematics, science, and technology. How proficient a student feels they are in a given subject, how important they view the given subject, and how interested they are in the given subject are important fields to research. Eccles and Wigfield (2002) have shown that student perceptions of ability, importance, and interest predict their performance and career choices. The results of this study were of importance to the Center School District because of the time, energy, and resources spent implementing the program at fifth grade. District leadership hoped the results of the study would help them determine if the program had the desired results and should be expanded to other grade levels. Results of this study were shared with Project Lead the Way, Inc. curriculum developers.

Delimitations

Following the advice of Lunenburg and Irby (2008), the following delimitations were identified and reported.

1. PLTW Launch was the only formal STEM curriculum implemented during the study.
2. Only fifth grade students from Center Elementary and Red Bridge Elementary in the Center School District were surveyed using an adapted survey from the University of Michigan's Childhood and Beyond project (Gender & Achievement Research Program, 2015c).
3. Only students' self-concept, value/importance, and interest in mathematics, science, and technology were gathered using the adapated survey.
4. Student gender was the only demographic variable utilized in the study.
5. Data were only collected from students who completed pre- and post-surveys during the 2015-2016 school year.

Assumptions

Following the advice of Lunenburg and Irby (2008), assumptions were operationalized for the purpose of this research. The following assumptions were made for this study.

1. All participants responded honestly and accurately to the adapted survey from the University of Michigan's Childhood and Beyond project.
2. Participants had no previous exposure to PLTW Launch.
3. The sample was representative of the Center School District's fifth grade population.

4. All survey data were gathered, recorded, and reported accurately.

Research Questions

Past research (PLTW, 2014b) claims, students who participate in PLTW in high school have more favorable feelings toward STEM careers than students who do not participate in PLTW. The research questions for this study were focused on determining the level of impact PLTW Launch had on fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology. The following research questions were used to guide this study:

RQ1. To what extent is there a difference in fifth grade students' self-concept of mathematics, self-concept of science, and self-concept of technology as measured before and after implementation of Project Lead the Way Launch?

RQ2. To what extent is there a difference in fifth grade students' value/importance of mathematics, value/importance of science, and value/importance of technology as measured before and after the implementation of Project Lead the Way Launch?

RQ3. To what extent is there a difference in fifth grade students' interest in mathematics, interest in science, and interest in technology as measured before and after the implementation of Project Lead the Way Launch?

RQ4. To what extent is the change in fifth grade students' self-concept of mathematics, self-concept of science, and self-concept of technology, as measured before and after the implementation of Project Lead the Way Launch, affected by gender?

RQ5. To what extent is the change in fifth grade students' self-concept of mathematics, self-concept of science, and self-concept of technology, as measured before and after implementation of Project Lead the Way Launch, affected by the selected STEM units taught (PLTW recommended vs. teacher recommended)?

RQ6. To what extent is the change in fifth grade students' value/importance of mathematics, value/importance of science, and value/importance of technology, as measured before and after the implementation of Project Lead the Way Launch, affected by gender?

RQ7. To what extent is the change in fifth grade students' value/importance of mathematics, value/importance of science, and value/importance of technology, as measured before and after the implementation of Project Lead the Way Launch, affected by the selected STEM units taught (PLTW recommended vs. teacher recommended)?

RQ8. To what extent is the change in fifth grade students' interest in mathematics, interest in science, and interest in technology, as measured before and after the implementation of Project Lead the Way Launch, affected by gender?

RQ9. To what extent is the change in fifth grade students' interest in mathematics, interest in science, and interest in technology, as measured before and after the implementation of Project Lead the Way Launch, affected by the selected STEM units taught (PLTW recommended vs. teacher recommended)?

Definition of Terms

According to Lunenburg and Irby (2008), key terms that allow for understanding and study replication should be defined. The following definitions were used in this study:

Interest. Interest is a general term used to describe how motivated an individual is to do a specific task, subject, or activity and how enjoyable an individual finds a specific task, subject, or activity (Denissen, Zarrett, & Eccles, 2007).

Project Lead the Way, Inc. (PLTW). An education company that provides STEM programs for students in kindergarten through high school (PLTW, 2014a).

Self-Concept. Self-concept is defined as how well an individual perceives they are at a specific task, subject, or activity (Denissen et al., 2007). It is a general term with several "facets of the self that contribute to an individual's general self-concept" (Ireson & Hallam, 2009, p. 201). The different facets that contribute to an individual's general self-concept are academic self-concept, social self-concept, emotional self-concept, and physical self-concept (Ireson & Hallam, 2009).

STEM. STEM is an acronym that represents the fields of science, technology, engineering, and mathematics (Gerlach, 2012).

STEM education. STEM education is an approach to teaching and learning that incorporates science, technology, engineering, and mathematics in an interdisciplinary fashion where students apply these specific disciplines to solve real-world problems (Tsupros, Kohler, & Hallinen, 2009).

Value/importance. Value and importance are interchangeable terms used to describe an individual's perception of how significant a specific task, subject, or activity is (Eccles & Wigfield, 2002; Simpkins, Davis-Kean, & Eccles, 2006).

Overview of the Methodology

A quasi-experimental research design was used in this study. A survey was used to collect data to determine if the change in students' self-concept, value/importance, and interest in mathematics, science, and technology was significantly different between genders after PLTW Launch implementation. The sample for the study was fifth grade students from an urban school district in Kansas City, MO. Paired-samples *t* tests were conducted to address research questions one through three. Two-sample *t* tests were conducted to address research questions four through nine.

Organization of the Study

In the first chapter, an introduction to the study was presented, which included the background, problem, purpose, and significance of the study. In addition, chapter one included the delimitations, assumptions, research questions, and the definition of terms. Lastly, an overview of the methodology was presented. Included in chapter two is the important literature relevant to the study, including STEM education; Student Attitudes in Education; Self-Concept, Value/Importance, and Interest in STEM; and Project Lead the Way. In chapter three, the methodology for the study is examined. Chapter four includes the descriptive statistics and the results of the data analyses and hypothesis testing. Provided in chapter five is a summary of the study, the findings related to the literature, the implications for action, and the recommendations for future research.

Chapter Two

Review of the Literature

STEM education, and the importance placed on it today, came from the concern that not enough Americans would have the necessary skills to fill future STEM jobs due to the low number of science, engineering, and mathematics degrees being obtained by U.S. students (Brown, Brown, Reardon, & Merrill, 2011; Business Higher Education Forum, 2007; Business Roundtable, 2005, U.S. Department of Education, Washington DC., 2000). In addition, several research organizations were concerned the United States would lose its economic and educational competitiveness if STEM education continued to remain a low priority for educators and of little interest to students (Business Higher Education Forum, 2007; Business Roundtable, 2005; National Science Board, 2007). To increase the number of students entering STEM fields, students need a positive self-concept in STEM subjects and need to view this field as valuable and important. The results of the research have concluded that how proficient a student feels they are in a given subject, how important they view the given subject, and how interested they are in the given subject predicts performance and career choices (Eccles & Wigfield, 2002).

The first purpose of this study was to determine the change in fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology after implementation of PLTW Launch. The second purpose was to examine if the change in self-concept, value/importance, and interest was significantly different between genders after implementation of PLTW Launch. The third purpose of this study was to determine if the change in self-concept, value/importance, and interest in mathematics, science, and technology was affected by the selected STEM units taught (PLTW recommended vs.

teacher recommended). Chapter two provides a review of the literature pertinent to this study, including STEM Education; Student Attitudes in Education; Self-Concept, Value/Importance, and Interest in STEM; and Project Lead the Way.

STEM Education

STEM education was a popular buzzword that many educators chose to use when discussing their progressive school programs. While STEM education has become a common term among educators, the definition and what STEM education encompasses is less than common (Brown et al., 2011). One such definition is an interdisciplinary approach that is often described as a meta-discipline where educators are integrating what have traditionally been separate subjects into "a new coherent field of study" that requires "real-world, rigorous, relevant learning experiences for students" (Vasquez, 2014, p. 11). According to the Congressional Research Service in a report for Congress, STEM education is simply the act of teaching and learning in the fields of science, technology, engineering, and mathematics (Gonzalez & Kuenzi, 2012). This definition is vague and allows for all teaching and learning in the areas of science, technology, engineering, and mathematics to be considered STEM. ACT (2014) is more precise and explicit with its definition of STEM, but similar to the Congressional Research Service, it makes no mention of integrating the subjects. Instead, ACT (2014) uses four categories to define STEM. According to ACT's (2014) definition, a student is participating in a STEM field if they are involved in science, computer science and mathematics, medical and health, and engineering and technology majors and occupations in their respective fields.

As more education systems join the STEM movement, it may be important for a common definition to be developed (ACT, 2014). Without a common definition, effectiveness from system to system might be challenging, and the likelihood of systems touting a strong STEM program, but, in turn, missing critical components may be high. A study conducted in the United States by Brown et al. (2011) found that only one-half of administrators, science teachers, and mathematics teachers who participated in the study were able to define STEM education. Many of the participants reported that they were, “Initially unsure of the meaning of STEM education when they were contacted for this study, but later used the Internet to determine its meaning” (Brown et al., 2011, p. 7). With a plethora of definitions on the Web, several different perceptions, wrong or right, are being formed due to the lack of consistency and clarity. An important note was that the administrators surveyed for Brown et al.’s (2011) study were in buildings with at least one educator enrolled in a STEM education and leadership program.

This notion of forming a common and shared understanding of STEM education was not only supported by President Obama’s Council of Advisors on Science and Technology (PCAST) but also extended to the idea that a common baseline for what students learn in STEM education should be adopted. In a PCAST report produced in 2010, the authors concluded that the nation would benefit from a common set of K-12 STEM standards. Furthermore, they argue that aligned assessments “that truly reflect what students need to learn” (Executive Office of the President, 2010, p. 39) would improve STEM education and provide a clearer description of STEM education.

An attempt to provide a clearer description of STEM education began in 2010 with the Next Generation Science Standards (NGGS) that were officially completed in April of 2013 (NGSS Lead States, 2013a). The Next Generation Science Standards were developed through a collaborative process with representation from the science community and over 25 states (NGSS Lead States, 2013a). When developing the standards, the authors used a three-dimensional approach. The first dimension outlined practices or behaviors that "scientists engage in as they investigate and build models and theories about the natural world and the key set of engineering practices that engineers use" (NGSS Lead States, 2013b, para. 2). Second, each standard listed crosscutting concepts that linked the different domains of the sciences (NGSS Lead States, 2013b). The last dimension focused the K-12 standards on what NGSS Lead States (2013b) believed to be "the most important aspects of science" (para. 5). The Next Generation Science Standards are grouped into four domains: physical sciences; life sciences; earth and space science; and engineering, technology, and applications of science (NGSS Lead States, 2013a). It is the fourth domain that connects STEM education to the standards and makes it a priority in the classroom.

Equally, if not more important to a clear and consistent definition of STEM education and clear learning targets, is the need for quality STEM teacher training programs. Gillespie (2015) argued that too much emphasis is placed on STEM education curriculum and not enough attention on the educators themselves. In his opinion, the nation is "building an edifice of courseware and curriculum without investing in the more crucial infrastructure of a national cadre of experienced and skilled educators who work together to change practice and lead improvement in their schools and beyond their classrooms" (Gillespie, 2015, p. 38). Instead of continually providing better resources and curriculum with the idea of improving STEM education, Gillespie (2015) argued the focus should be on creating and sustaining STEM teacher leaders who develop and share engaging pedagogy that inspires and motivates students to participate in STEM education.

One such program that aims to meet this challenge is the Knowles Science Teaching Foundation (KSTF). KSTF (2015a) was founded in 1999 with four cornerstones to improving STEM education, which include (1) developing outstanding teachers, (2) being a catalyst for teacher leadership, (3) generating and sharing knowledge, and (4) building a national professional community. The program is a five-year fellowship designed to provide the necessary support for beginning mathematics and science teachers. Through this fellowship, KSTF provides a comprehensive and cohesive professional development experience for their fellows (Gillespie, 2015). When finished with the program, KSTF (2015b) fellows are equipped with skills that allow them to be successful in mentoring new teachers, piloting and testing curricular resources, leading professional development, and serving as a resource for the administration when developing school improvement plans.

Horizon Research Inc. has found promising results with the KSTF program. With regard to the first cornerstone of the KSTF program, Horizon Research Inc. found that more than 87% of school leaders across the United States who have had experience with KSTF fellows felt that KSTF Fellows were in the top 25% of teachers with similar experiences, with at least half of the respondents rating KSTF Fellows in the top 5% of teachers with similar experiences (Jaffri & Banilower, 2014). In relation to the second cornerstone of the KSTF program, Horizon Research Inc. found that 81% of school leaders felt that KSTF Fellows were in the top 25% of teachers with leadership skills (Jaffri & Banilower, 2014). Horizon Research Inc. concluded that school leaders rated

KSTF Fellows in the top 25% as compared with other teachers regarding classroom practice, professional relationships with colleagues, and teacher leadership. School leaders also felt they had an increased level of confidence with their KSTF fellows (Jaffri & Banilower, 2014).

Education systems must use effective STEM curriculum that is clearly defined and aligned with the core beliefs of STEM education ensuring an interdisciplinary approach where students are applying STEM skills to solve real-world problems (Tsupros et al., 2009). However, an effective STEM curriculum is not enough. Education systems must also ensure educators have been thoroughly trained and are capable of developing and sharing pedagogy that inspires and motivates students to participate in STEM education (Gillespie, 2015).

Status of STEM education in the United States. The United States has been examining its mathematics and science education status for over a decade. Various reports, dated as early as 2000, from business and government organizations continually warn the United States that it is losing its "competitive edge in the global economy" due to its poor performance in mathematics and science (Kennedy & Odell, 2014, p. 248). A report from the U.S. Department of Education (2000) included claims that students in the United States "are falling behind" and are "no longer 'world-class learners' when it comes to mathematics and science" (p. 4). The U.S. Department of Education (2000) report included three goals and several action strategies that would improve mathematics and science instruction in the United States. The three goals and action strategies concentrated on (1) improving K-12 instruction in the areas of mathematics and science, (2) increasing the number of mathematics and science teachers in K-12, and (3) making the teaching profession more appealing for college students majoring in mathematics and science (U.S. Department of Education, 2000).

In 2005, a report published by The Business Roundtable included a similar disposition to the 2000 report written by the U.S. Department of Education. The Business Roundtable (2005) report was written by 15 prominent business organizations, and like the mentioned U.S. Department of Education (2000) report, included a deep concern with the current mathematics and science education in the United States. In addition to mathematics and science, the Business Roundtable (2005) report stated that there is a “critical situation in U.S.” technology and engineering with indicators ranging from “measurable declines in U.S. innovation, such as patents and scientific articles, to soaring numbers of students in Asia majoring in these fields, to U.S. students’ lagging interest and measured performance in math and science” (Business Roundtable, 2005, p. 5).

As with the U.S. Department of Education (2000) report, the Business Roundtable (2005) report included a goal for the United States to “double the number of science, technology, engineering, and math graduates by 2015” (Business Roundtable, 2005, p. 10). To accomplish this goal, the Business Roundtable (2005) report provided five recommendations that focused on “critical areas that affect the choices made by students now in the pipeline” (Business Roundtable, 2005, p. 10).

1. Build public support for making science, technology, engineering and math improvement a national priority.

2. Motivate U.S. students and adults to study and enter science, technology, engineering and mathematics careers, with a special effort geared to those in currently underrepresented groups.
3. Upgrade K-12 math and science teaching to foster higher student achievement.
4. Reform visa and immigration policies to enable the United States to attract and retain the best and brightest science, technology, math and engineering students from around the world to study for advanced degrees and stay to work in the United States.
5. Boost and sustain funding for basic research, especially in the physical sciences and engineering. (Business Roundtable, 2005, pp. 10-13)

Like the U.S. Department of Education (2000) and Business Roundtable (2005) reports, the Business Higher Education Forum (BHEF) (2007) released a report stating, “American students today have limited interest in studying mathematics and science, and academic achievement in these two foundational disciplines is demonstrably low” (p. 4). The BHEF (2007) report included three recommendations that addressed factors that lead to a strong “mathematics and science teacher workforce” (p. 12). First, BHEF (2007) recommended an increased effort to recruit mathematics and science teachers. Second, BHEF (2007) recommended that strategies and programs be developed that will retain new and experienced teachers. Third, BHEF (2007) recommended that educators be provided ongoing training to improve teacher effectiveness.

Ten years after the U.S. Department of Education’s (2000) report and recommendations, President Obama asked the President’s Council of Advisors on

Science and Technology (PCAST) to review the current status of STEM education and provide "specific recommendations concerning the most important actions that the administration should take to ensure that the United States is a leader in STEM education in the coming decades" (Executive Office of the President, 2010, p. vii). The 2010 PCAST report stated that little improvement had been made since the U.S. Department of Education's (2000) report and that the U.S. education system is failing students in the areas of mathematics and science. "International comparisons of our students' performance in science and mathematics consistently place the United States in the middle of the pack or lower" (Executive Office of the President, 2010, p. v).

Similar to the other reports, the PCAST (2010) report provided President Obama with two main conclusions and seven recommendations (Executive Office of the President, 2010). First, the authors of the report declared a need to "prepare all students, including girls and minorities who are underrepresented in these fields, to be proficient in STEM subjects" (Executive Office of the President, 2010, p. 11). Additionally, the authors argued the need to "inspire all students to learn STEM and, in the process, motivate many of them to pursue STEM careers" (Executive Office of the President, 2010, p. 11). The second conclusion from the PCAST (2010) report was that the Federal Government needed to develop a coherent strategy with oversight from strong leadership. The authors urged President Obama to provide additional Federal funding to "transform STEM education" (Executive Office of the President, 2010, p. 11). Furthermore, the authors of the PCAST (2010) report stated a need to identify proven programs that could be replicated and disseminated (Executive Office of the President, 2010).

In addition to the two main conclusions, the PCAST (2010) report included seven recommendations that aligned with the report's conclusions. The recommendations urged for the continuing development of common standards in mathematics and science, improving teacher recruitment and retention, recognizing excellence in the classroom, using educational technology effectively, and providing students with STEM experiences outside of the classroom. Additionally, the authors of the PCAST (2010) report advised educational systems to identify effective STEM schools that could serve as a model for new STEM schools. Lastly, the authors believed it to be of major importance to develop and maintain strong leadership at the national level (Executive Office of the President, 2010).

From 2000 to 2010, several major reports were produced, all of which were insistent that something be done with the nation's education system, specifically in mathematics and science. While there was much insistence to improve, there appeared to be little, if any, improvement from 2000 to 2010. Each report produced made specific recommendations and established goals that must be reached if the United States wished to continue its economic growth and prosperity. The final report discussed, PCAST (2010), connects the previous reports and translates "these ideas into a coherent program of Federal action to support STEM education in the United States" (Executive Office of the President, 2010, p. vii).

STEM Data up to 2010. Each of the four reports discussed in the previous section detailed past achievement data that raised concerns about the U.S. education system. This section focuses on the specific data each report used to support its conclusions and recommendations. While the reports discussed in the previous section were written during a ten-year time span, 2000 to 2010, data from as early as the 1970s was used to highlight a decline in the U.S. education system and a need for transformation.

The U.S. Department of Education (2000) report provided data from an international and national assessment dating back to the mid-1990s. The Trends in International Mathematics and Science Study (TIMSS) is a mathematics and science assessment administered to students in fourth, eighth, and twelfth grades. Results from TIMSS are used to compare U.S. students to students in other countries. TIMSS was first administered in 1995 (National Center for Education Statistics, 2015e). The National Assessment of Educational Progress (NAEP) is a national assessment for students in fourth, eighth, and twelfth grade that allows for national comparison in a variety of subjects, including science and mathematics (National Center for Education Statistics, 2015a). The NAEP assessment changes very little from year to year, allowing academic progress to be reported over time (National Center for Education Statistics, 2015a).

Results from TIMSS and NAEP have shown poor U.S. performance since the 1970s (U.S. Department of Education, 2000). U.S. student achievement increases have been minimal and are below the pace of international students. While U.S. achievement increases have been minimal, international students since the 1970s have been gaining ground and many are now surpassing U.S. students (U.S. Department of Education, 2000). Results from the 1995 TIMSS test reveal the trend that U.S. students are being surpassed by international students. Students in the fourth grade had scores that were above the international average in mathematics and science, with only one nation outscoring the US in science. With an analysis of the results from eighth grade, this superiority began to fade. Eighth grade students had TIMSS scores that were marginally above the international average in science and faintly below the international average in mathematics. By eighth grade, nine nations had better science averages than the United States compared to fourth grade where only one nation had better science averages. Equally alarming, twelfth grade U.S. students assessed in advanced mathematics and physics scored so poorly that no other country whose students took the assessment had lower advanced mathematics scores, and only one country had lower physics scores (U.S. Department of Education, 2000).

The NAEP results from 1996 support the claims made by the TIMSS scores from 1995. “Despite some improvements in NAEP mathematics scores since the 1970s, our students’ performance in science and mathematics has remained at disappointing levels for nearly 30 years” (U.S. Department of Education, 2000, p. 11). In 1996, less than one-third of U.S. students in fourth, eighth, and twelfth grade scored proficient or above in mathematics and science. Equally troubling, “more than one-third of U.S. students scored below the ‘Basic’ level” in mathematics and science (U.S. Department of Education, 2000, p. 11).

Using national and international data, the Business Roundtable (2005) report provided equally alarming data to support the claim that the U.S. education system needs an overhaul, especially in the areas of mathematics and science. Consider these facts in their report:

- By 2010, if current trends continue, more than 90 percent of all scientists and engineers in the world will be living in Asia.

- South Korea, with one-sixth of our population, graduates as many engineers as the United States.
- More than 50 percent of all engineering doctoral degrees awarded by U.S. engineering colleges are to foreign nationals.
- The number of engineering degrees awarded in the US is down 20 percent from the peak year of 1985. (Business Roundtable, 2005, p. 1)

The report continues with details showing U.S. students lack motivation and interest in the areas of mathematics and science. Fewer than 6% of high school seniors who took a college entrance exam in 2002 indicated an interest in pursuing an engineering degree, down 33% from the previous decade (Business Roundtable, 2005).

The BHEF (2007) report supported claims using data from the U.S. Department of Education (2000) and Business Roundtable (2005) reports claiming, "American students today have limited interest in studying mathematics and science, and academic achievement in these two foundational disciplines is demonstrably low" (BHEF, 2007, p. 4). The BHEF (2007) raised further concerns about staffing, asserting that the US by 2015 would need an additional 280,000 mathematics and science teachers. Nowhere are these teacher shortages felt more than in high-minority and high-poverty classrooms. "In 2002, 72% of high-minority middle school mathematics classes were taught by teachers who had not majored or minored in mathematics, compared with 55% of low-minority classes" (BHEF, 2007, p. 9). Equally concerning is the shortage of minority teachers. "In 2003, 42% of public school students were from minority groups – yet only 16% of the teachers were minorities" (BHEF, 2007, p. 9). Lastly, the authors of the BHEF (2007) report were concerned with the large percentage of teachers leaving the profession citing that, "Approximately half of all teachers leave within 5 years of entering the profession" (p. 10). These numbers are magnified in poor schools where "the rate of attrition is 50% higher in poor schools versus wealthy ones" (BHEF, 2007, p. 10).

Lastly, the PCAST (2010) report included similar data to the three previous reports using results from the Program for International Student Assessment (PISA). PISA is a mathematics, science, and reading assessment administered internationally to 15-year-olds every three years. PISA testing began in 2000 (National Center for Education Statistics, 2015b). Analyzing results from the 2006 PISA, U.S. 15-year-olds scored below most other nations in their ability to apply what they learned in mathematics and science (Executive Office of the President, 2010). Maybe even more alarming than how poorly U.S. students were performing on international assessments was the lack of STEM degrees being attained by U.S. students. "Only about a third of bachelor's degrees earned in the United States are in a STEM field, compared with approximately 53 percent of first university degrees earned in China, and 63 percent of those earned in Japan" (Executive Office of the President, 2010, p. 2).

The 2010 PCAST report raised additional concerns noting an alarming gender gap in STEM fields. The gap is not an aptitude gap, but rather an interest gap. "Although girls earn high school mathematics and science credits at the same rate as boys, and earn slightly higher grades in those classes, they choose STEM majors in college at a much lower rate than boys" (Executive Office of the President, 2010, p. 3). This interest gap extends into college where only 40% of high school students interested in STEM pursue a degree in a STEM field. A troubling fact is that nearly 60% of the students who do pursue a STEM degree decide to change majors and pursue a degree in a non-STEM field

(Executive Office of the President, 2010). The gender gap appears even larger when looking at the science and engineering workforce. Using cited literature from the 2010 PCAST report, the National Science Foundation (2009) reported in 2007 that only 11% of U.S. engineers and 26% of mathematical and computer scientists were females.

The problems in the areas of mathematics and science and its STEM-connected fields are well documented in the literature. The US has been facing mathematics and science achievement problems, especially as students progress through the grade levels (U.S. Department of Education, 2000). Equally troubling is the lack of interest U.S. students show in STEM-related fields (BHEF, 2007; Executive Office of the President, 2010). The achievement gaps and lack of interest are exacerbated when considering minorities and women (BHEF, 2007; Executive Office of the President, 2010). The following section includes data between 2010 and 2015 to determine if the recommendations and goals set forth by earlier reports improved STEM achievement and motivation.

STEM data 2010-2015. The data used in the previous reports spanned forty years from 1970 to 2010 with much of the data coming between 1995 and 2006. The authors of the reports emphasized a need for drastic improvements in the U.S. education system, specifically STEM related subjects. Each report stated goals and provided recommendations that would fix the mathematics and science concerns. This section provides data from 2010 to 2015 to determine if the goals and recommendations from the early 2000s improved U.S. achievement in mathematics and science.

The average U.S. mathematics PISA scale score in 2012 was 481 out of 1000. Comparing this to a high of 613 in Shanghai-China and to Organisation for Economic

Cooperation and Development (OECD) average of 494, the US was measurably below 29 education systems (National Center for Education Statistics, 2015c). Analyzing top proficiency levels, 9% of 15-year old U.S. students scored at the top proficiency level with 27 education systems having better top proficiency averages. Comparing this to a high of 55% in Shanghai-China and 13% average for OECD countries, the US scored significantly behind the developed world when looking at top proficiency levels (National Center for Education Statistics, 2015c). When comparing below proficiency scores, the US had 26% in this category while the OECD average was 23% with a low of 4% in Shanghai-China. Twenty-nine education systems had fewer students scoring below proficiency than the US (National Center for Education Statistics, 2015c).

Analyzing science scores, the average U.S. PISA science score in 2012 was 497 out of 1000. Comparing this to a high of 580 in Shanghai-China, 555 in Hong Kong-China, 551 in Singapore, 547 in Japan, and 545 in Finland, the US was significantly behind the top five performing education systems. However, the U.S. average score was not measurably different from the OECD average of 501. Twenty-two education systems had higher averages than the US. Analyzing top proficiency scores, PISA reported that 7% of U.S. students scored at the top proficiency level while the OECD averaged 8% and was not measurably different from the US. Shanghai-China received the highest scores with 27% at the top proficiency level. Alarming, 167 education systems had higher percentages at the top proficiency level than the US. When considering below proficiency scores, the US was comparable to the OECD average with the US and OECD both averaging 18% below the proficiency threshold. Shanghai-China was 15 points lower than the US with only 3% below the proficiency threshold. Twenty-one education systems outperformed the US when considering below proficiency scores (National Center for Education Statistics, 2015c).

When analyzing the 2012 PISA results and the 2011 TIMSS fourth grade and eighth grade results, the trend that U.S. students perform better at younger ages, especially in mathematics, and slowly get surpassed by other nations still appeared to be true. The average mathematics scale score of U.S. fourth grade students was 541 out of 1000. The international scale score average was 500. U.S. fourth grade students' mathematics TIMSS scores were in the top 15 internationally. When looking at advanced scores, only seven education systems had higher percentages of advanced fourth grade mathematics scores than the US (National Center for Education Statistics, 2015d). Compared to U.S. fourth grade students, U.S. eighth grade students' TIMSS scores declined with an average mathematics scale score of 509 out of 1000. The international scale score average was 500. Eighth grade mathematics scores drastically declined placing the US in the top 25 internationally in mathematics, 10 spots worse than the fourth grade rankings. The decline also appeared with the advanced scores. Eleven education systems had higher percentages of advanced eighth grade mathematics scores than the US, a drop by four spots (National Center for Education Statistics, 2015d).

Analyzing TIMSS science scores, fourth grade U.S. students had an average scale score of 541 out of 1000, while the international scale score average was 500. When comparing rankings, U.S. fourth grade students scored in the top ten with only six education systems outperforming the US and three education systems having scores that were not measurably different. When looking at advanced scores, U.S. fourth grade students once again scored in the top 10 with only three education systems outscoring

U.S. fourth grade students and six education systems had averages that were not measurably different (National Center for Education Statistics, 2015f). Holding true with the mathematics trends, U.S. eighth grade students' science scores began to decline. U.S. eighth grade students had an average scale score of 525 while the international eighth grade science scale score average was 500. U.S. eighth graders placed in the top 23 education systems in the world, a decline of 13 spots when comparing eighth grade to fourth grade rankings. When looking at advanced scores of U.S. eighth grade students, 12 educational systems outperformed the US, and 10 educational systems had scores that were not measurably different (National Center for Education Statistics, 2015f). Table 2 provides a summary of the 2011 TIMSS and 2012 PISA results and compares US rankings in mathematics and science.

Table 2

U.S. 2011 TIMSS and 2012 PISA Results

	Average Scale Score	TIMSS International/ PISA OECD Average Scale Score	U.S Ranking
Fourth Grade TIMSS Mathematics	541	500	Top 15
Fourth Grade TIMSS Science	544	500	Top 10
Eighth Grade TIMSS Mathematics	509	500	Top 24
Eighth Grade TIMSS Science	525	500	Top 23
PISA Mathematics	481	494	Top 30
PISA Science	497	501	Top 23

Note. U.S. fourth and eighth grade average TIMSS and PISA mathematics and science scaled scores compared to OECD average TIMSS and PISA scaled scores. Adapted from National Center for Education Statistics, 2015, and retrieved from http://nces.ed.gov/surveys/pisa/pisa 2012/pisa2012highlights_1.asp and National Center for Education Statistics, 2015, and retrieved from https://nces.ed.gov/timss/results11_math11.asp.

According to national and international achievement data, it does not appear the U.S. education system has improved since the alarm was sounded in 2000 by the U.S. Department of Education. Mathematics and science student achievement continues to be in the middle of the pack of OECD countries. Additionally, the trend that U.S. students perform better in the earlier grades appears to have continued. While student achievement in mathematics and science has not improved, the next section includes information related to whether interest and motivation to enter STEM fields, including subgroups, has increased with all of the recommendations and reports discussed in the previous sections.

STEM interest and motivation. The reports discussed in previous sections highlighted not only an achievement gap but also an interest gap. According to the reports, U.S. students were not only performing below average in mathematics and science, but they were also uninterested in fields that required mathematics and science (BHEF, 2007; Business Roundtable, 2005; U.S. Department of Education, 2000; Executive Office of the President, 2010). Furthermore, far more males than females pursued STEM degrees. Equally alarming a wide racial gap existed (BHEF, 2007; Business Roundtable, 2005; U.S. Department of Education, 2000; Executive Office of the President, 2010). Data between 2010 and 2015 is included in this section to determine if STEM interest levels of U.S. students improved, the gender gap closed, and racial disparity narrowed due to the goals and recommendations set forth by the previously mentioned reports dated between 2000 and 2010.

The 2015 U.S. News/Raytheon STEM Index, a report that allows STEM progress to be measured and reported, shows that gains between 2000 and 2014 in STEM degrees granted and employment have occurred, but “gaps between men and women and between whites and minorities in STEM remain deeply entrenched” (Bolkan, 2015, para. 2). Overall, STEM interest increased by 20% from 2004 to 2014 (Cook, Mason, Morse & Neuhauser, 2015). While overall the US saw an increase in STEM interest, key findings continued to show a measurable discrepancy between subgroups. Male high school students had an increase of more than 5% in engineering from 2000 to 2014 ending above 30%. On the other hand, female high school students’ interest in engineering remained stagnant from 2000 to 2014 with only 3% of high school females in 2014 reporting interest in engineering (Cook et al., 2015). The same appeared to be true with technology. Male high school students had an increase in technology interest that was close to 5% from 2000 to 2014 ending above 15% in 2014 (Cook et al., 2015). During this same time, female high school students had a decline in technology interest with only 2% reporting an interest in technology in 2014 (Cook et al., 2015). With regard to race, Black high school students in the year 2000 showed greater interest in engineering than did their White peers. Over the next 14 years, Black students' interest declined, and White students' interest increased surpassing their Black peers by 2014 (Cook et al., 2015). Interest in technology revealed a similar trend with Black high school students in 2000 showing a greater interest in technology than did their White peers. Over the next 14 years, black students' interest decreased while white students' interest increased minimally. By 2014, both races showed a similar interest in technology (Cook et al., 2015).

When looking at achievement and degrees earned in STEM fields, the 2015 STEM Index report shows a continued gap between gender and race. Male high school students outperformed their female peers on all STEM-related advanced placement tests. Furthermore, males outperformed their female peers by an average of 30 points on the 2014 SAT mathematics section (Bolkan, 2015). Black students fared even worse on the mathematics section scoring on average 105 points lower than did their White peers (Bolkan, 2015). From 2009 to 2014, White students showed an increase from 16.8% to 19.5% in bachelor degrees awarded in STEM fields. The number of STEM bachelor degrees awarded to Black students also grew during this same period, but at a much slower rate and significantly below their White peers showing an increase from 12.7% in 2009 to only 13.6% in 2014 (Bolkan, 2015). This same discrepancy was also seen between genders. In 2014, only 6% of associate degrees earned by females were in STEM fields compared to 20% for male students. The percent increased for women earning bachelor degrees in STEM fields to 10%, but still significantly below their male peers at 28% (Bolkan, 2015).

Student Attitudes in Education

Attitudes and beliefs predict and determine individual choices, how long one is willing to persevere, and performance (Uguroglu & Walberg, 1979; Wigfield & Eccles, 1983). This relationship among attitudes, perception of ability, and achievement begins to form at an early age, is mildly disrupted during early adolescence, and strengthens as students mature and develop a more realistic view of their abilities (Denissen et al., 2007; Eccels et al., 1989; Wigfield et al., 1997). Researchers have agreed to the term self-concept to describe an individual's perception of their abilities toward a specific task, subject, or activity (Denissen et al., 2007). Wigfield and Eccels's (2000) expectancy-value model of achievement and self-concept are discussed in detail in the following sections.

Expectancy-value theory of motivation. A long-standing belief by many motivation theorists is that an individual's choice, perseverance and persistence, and success or lack of success can be predicted by how one feels they will do on a specific task or activity and how much value one places on the specific task or activity (Wigfield & Eccels, 2000). This belief that an individual's confidence with a specific task or activity can influence future choices, persistence, and ultimately performance is known as the expectancy-value theory of motivation (Wigfield & Eccles, 2000). "Expectancies and values are assumed to be influenced by task-specific beliefs such as ability beliefs, the perceived difficulty of different tasks, and individuals' goals, self-schema, and affective memories" (Wigfield & Eccles, 2000, p. 69). Likewise, using this theory, expectancies and values are projected to influence choices, effort, persistence, and performance (Wigfield & Eccles, 2000).

Eccles-Parson et al. (1983) defined expectancies as a child's belief in how well he or she will perform on an impending task. Ability beliefs differ slightly in that these beliefs focus on present ability where expectancies focus on future abilities (Eccles et al., 1983; Wigfield & Eccles, 2000). Empirically, expectancies and ability beliefs have been proven highly related (Eccles, Wigfield, Harold, & Blumenfeld, 1993; Wigfield & Eccles, 2000). Denissen et al. (2007) and others use the term self-concept in place of expectancies and ability beliefs. "Eccles and Wigfield demonstrated that domain-specific expectations for success and ability self-concepts load on the same factor and therefore can be treated empirically as the same construct" (Eccles, O'Neil, & Wigfield, 2005, p. 238). Self-concept, along with value/importance and interest, is discussed in depth in the section below.

Self-concept, value/importance, and interest. A student's expectancy of performance, or their self-concept, begins to develop at an early age (Denissen et al., 2007). These representations of performance begin to develop as the student interprets achievement and receives feedback in relationship to a particular task, subject, or activity (Wigfield et al., 1997). When students interpret the achievement and feedback as positive, their self-concept within this specific task, subject, or activity increases. When students interpret achievement and feedback as negative, their self-concept within this specific task, subject, or activity decreases (Wigfield et al., 1997; Wigfield & Eccles, 1983). These self-competency beliefs can ebb and flow as the student takes into account previous and current achievement (Denissen et al., 2007). A student's self-concept tends to stabilize as the student matures and develops "a more realistic picture of their relative competencies" (Eccles et al., 1989, p. 285.).

Self-concept is important to study, as researchers have discovered a relationship between self-concept, value/importance, interest, and achievement (Denissen et al., 2007; Wigfield et al., 1997). When a student has a strong self-concept within a specific task, subject, or activity, the student is more likely to continue to choose this task, subject, or activity and shows greater interest in the specific task, subject, or activity (Denissen et al., 2007; Wigfield et al., 1997). From a statistical standpoint, a meta-analysis by Lent, Brown, and Hackett (1994) found an average correlation of .53 between self-concept and interest. This positive relationship is reciprocal in nature and has been shown to form as early as the first grade and strengthen as the student ages (Eccles et al., 1993; Marsh, Trautwein, Ludtke, Koller, & Baumert, 2005; Wigfield et al., 1997).

In addition to interest, self-concept within a specific task, subject, or activity is also related to achievement outcomes within the same task, subject, or activity (Denissen et al., 2007; Wigfield & Eccles, 1983; Wigfield et al., 1997; Yoon, Eccles & Wigfield, 1996). Valentine, DuBois, and Cooper (2004) conducted a meta-analysis of 60 independent samples and found a small, but significant, relationship between self-concept and achievement. Marsh et al. (2005) found similar results between self-concept and achievement through a longitudinal study with nearly 8,000 German seventh grade students. The relationship between self-concept and achievement appears to be reciprocal across time (Marsh et al., 2005; Eccels et al., 1983). "Empirical studies have supported the significance of these bidirectional influences between self-concept of achievement and achievement” (Denissen, 2007, p. 431).

Self-concept within a specific task, subject, or activity and the relationship between how the individual values the task, subject, or activity and the importance placed on the task, subject, or activity can be seen as early as first grade (Eccles et al., 1993). Wigfield et al. (1997) conducted a longitudinal study with elementary students from a large Midwestern metropolitan area and found a relationship between value and importance, task choice, and competence beliefs. Wigfield et al. (1997) noted, “Competence beliefs related positively to their valuing of the activity, particularly their interest in the activity” (p. 460). It can then be assumed that an adolescent who places high value or importance on a specific task, subject, or activity is likely to choose this specific task, subject, or activity (Wigfield et al., 1997). However, as the child ages, value and importance placed on academic achievement tends to decline, most notably in mathematics (Eccles et al., 1989). Unlike self-concept and interest or self-concept and achievement, self-concept and the value or importance placed on a specific task, subject, or activity does not appear to have a strong reciprocal relationship. Instead, the value or importance placed on a specific task, subject, or activity seems to drive the student’s self-concept, at least in early adolescence (Yoon et al., 1996).

In summary, student attitudes toward a specific task, subject, or activity, and their self-concept toward this same task, subject, or activity, affects their choices and ultimately their overall performance (Uguroglu & Walberg, 1979; Wigfield & Eccles, 1983). Self-concept is shown to have a reciprocal relationship with interest and achievement (Denissen et al., 2007; Eccles et al., 1993; Eccles et al., 1983; Marsh et al., 2005; Wigfield et al., 1997). While a relationship is present between self-concept and value/importance, it is not reciprocal with value/importance driving self-concept (Yoon et al., 1996).

Self-concept, Value/Importance, and Interest in STEM

Major studies conducted by Denissen et al. (2007), Eccles et al. (1983, 1993), Marsh et al. (2005), and Wigfield et al. (1997) have revealed relationships between self-concept, importance/value, and interest in a variety of educational domains. Confidence, significance, and interest in a specific domain influence choice and create persistency. Additionally, reports by BHEF (2007), Business Roundtable (2005), U.S. Department of Education (2000), and the Executive Office of the President (2010) have revealed that U.S. students are behind academically and show less interest in engineering, mathematics, and science compared to OECD countries. Low interest and poor performance are proliferated among females and minorities. The following section includes a discussion of doctoral studies from 2002-2015 and their findings in relation to self-concept, importance/value, and interest in STEM.

Martin (2002) conducted a study to determine if student attitudes toward mathematics differed between genders. Martin's (2002) study consisted of 267 gifted male and female students in third through sixth grade in the southeastern coast of the United States. Martin (2002) surveyed participants using the Fennema-Sherman Mathematics Scale to measure student attitudes toward mathematics. Overall, Martin's (2002) study indicated that males in third through fifth grade have less negative attitudes toward mathematics than females in third through fifth grade. The sixth grade males and females had the most negative attitudes toward mathematics. However, the overall attitudes toward mathematics in sixth grade did not significantly differ between genders. When analyzing attitude domains, Martin (2002) found anxiety and motivation to be the most significant domains. Female anxiety levels were significantly higher than were the anxiety levels of their male peers. While negative attitudes toward mathematics motivation were significantly high, the results of Martin's study did not differ between genders. Martin's (2002) findings supported those of the U.S. Department of Education (2000) which reported that overall attitudes, interest, and motivation in mathematics were alarmingly low and that males typically had more positive attitudes toward mathematics than did females.

Seo (2003) conducted a study of 459 fifth grade students in South Korean elementary school mathematics classrooms to "better understand the patterns of various motivational constructs and how each construct related to strategic and cognitive processes and academic achievement" (p. iii). Seo used a 51-item self-report questionnaire to determine mathematics "competence-related beliefs, task values, achievement goals, and strategic and cognitive process" (p. 59). Questions used to measure competence-related beliefs and task values came from Wigfield et al.'s (1997) work. Wigfield et al.'s (1997) work, which is directly connected with the Childhood and Beyond Wave 5 survey designed by Eccels et al. (1983) and used for the current study. Seo (2003) found competence-related beliefs and task values "positively related to mathematics achievement" (p. 82). Seo (2003) also found that competence-related beliefs had direct effects on task values and academic achievement. Seo's (2003) findings supported findings by Eccles et al. (1989, 1983) and Wigfield et al. (1997) that showed a relationship between competence-related beliefs and interest, achievement, and value/importance. Denissen et al.'s (2007) finding supported Seo's (2003) findings that competence-related beliefs had direct effects on task values and academic achievement.

Tai, Liu, Maltese, and Fan (2006) conducted a study to determine if career interests in eighth graders, specifically science, would result in a related college degree. Tai et al.'s (2006) study included more than 3,000 participants from across the US who completed an interest survey in 1988 and had obtained a degree from a four-year college or university. Tai et al. (2006) found that students who expected a career in a science field while in eighth grade were "1.9 times more likely to earn a life-science baccalaureate degree than those who did not expect a science-related career" (p. 1144). Even more profound, "students with expectations for a science-related career were 3.4 times more likely to earn physical science and engineering degrees than students without similar expectations" (p. 1144). Tai et al. (2006) also found that high achieving mathematics students who also showed a career interest in science were far more likely to earn a degree in physical science or engineering. Tai et al. (2006) found that students who scored one standard deviation above average and "expected a science-related future career" had an estimated probability of 51%, "whereas the estimated probability of the student who expected a nonscience career was 19%" (p. 1144). Tai et al.'s (2006) findings supported the idea that encouragement and career exploration early on may increase student interest and ultimately lead to more students studying STEM fields in college.

Hafner (2008) conducted a study of eighth grade students to determine if there was a correlation between mathematics self-efficacy, levels of anxiety, and achievement in mathematics. Hafner's (2008) study included 124 students from southeastern

Massachusetts. The sample was evenly distributed with 48% of the participants being male and 52% being female. Participants were administered two self-reports. The Mathematics Self-Efficacy scale was used to determine self-efficacy levels. The Mathematics Anxiety Rating Scaled for Adolescents was used to determine anxiety levels. Hafner (2008) used test scores from the most recent semester to determine mathematics achievement levels. Hafner (2008) found that mathematics self-efficacy and anxiety levels were “significantly and negatively correlated” (p. 54). Hafner (2008) also found that mathematics self-efficacy and achievement were “significantly and positively correlated” (p. 54). Though not as strong, Hafner (2008) found a negative correlation between anxiety and achievement. However, it is important to note that Hafner (2008) found that once “self-efficacy was added to the model, anxiety was no longer significant as a predictor” (p. 58). Hafner (2008) concluded that mathematics self-efficacy “mediated the effects of math anxiety on achievement” (p. 59). Hafner’s (2008) findings supported findings by Denissen et al. (2007) and Eccles et al. (1989, 1983) that suggested self-efficacy and achievement are positively correlated.

Kaya (2008) conducted a study of fourth grade students across five countries (Australia, Japan, Scotland, Singapore, and U.S.) to examine the effects student-level factors and classroom-level factors had on science achievement. Kaya (2008) categorized gender, self-confidence, and home resources as student-level factors. Teacher characteristics, instructional variables, and classroom composition were categorized as classroom-level factors. The 2003 TIMSS was used as the outcome variable. Kaya (2008) found that student-level factors “were consistently related to science achievement” (p. ix). When controlling for gender and home resources, Kaya

(2008) determined that self-confidence positively affected 2003 TIMSS science scores in all five countries. Interestingly, when controlling for self-confidence and home resources, Kaya (2008) deduced no significant differences between gender achievements on the 2003 TIMSS for students living in Australia, Japan, and the US. These findings strengthened research by Denissen et al. (2007) and Eccles et al. (1989, 1983) who claimed that self-concept significantly influenced achievement and interest. Additionally, these findings strengthened the recommendations by BHEF (2007), Business Roundtable (2005), U.S. Department of Education (2000), and the Executive Office of the President (2010) to increase STEM interest, especially with female and minority students.

Oware (2008) conducted a study with 18-gifted third through sixth grade students to determine their perceptions regarding engineering. Participants were enrolled in a six-week “Why Do Buildings Fall Down” Saturday learning camp sponsored by Purdue University. To determine student attitudes, Oware (2008) asked them to complete a questionnaire, draw an “engineer doing engineer work,” and participate in a student interview (p. 69). Oware (2008) found that participants described engineers as “people who: 1) do physical labor activities such as building, working on, or repairing objects or 2) are involved in the design, planning, or preparation needed for the creation of objects” (p. 160). The fifth and sixth grade participants were more likely to see an engineer as someone who manages people and prepares directions for others to follow. After six weeks of engineering experience, Oware (2008) found that students’ perceptions changed becoming more accurate and specific, especially with the design process that engineers use. Oware (2008) also found that “students’ perceptions of engineers and engineering are influenced by family members, personal experiences, and the media" (p. 161). Oware's (2008) finding was important to note as it aligned with recommendations in the literature made by the Business Roundtable (2005) to "launch a campaign to help parents, students, employees and community leaders understand why math and science are so important to individual success and national prosperity" (p. 10).

Loustalet (2009) conducted a study at Oregon Institute of Technology to determine if students who achieve As (mastery) in introductory mathematics college courses have differing attitudes than students who achieve Cs (pass) in introductory mathematics courses. The study consisted of 96 students with half of the participants being female. There was also an even distribution between achievement with 44 participants receiving an A and 52 participants receiving a C in Math 100, Math 111, or Math 112. Loustalet (2009) used the Views About Math Survey to determine student attitudes. He found that students who received As had significantly more positive attitudes toward mathematics than students who received Cs. However, Loustalet (2009) found no significant differences between genders. Loustalet (2009) also found that students who earned As were more likely to rate their confidence level as "above average" than students who earned Cs. Once again, Loustalet (2009) found no significant differences between genders. Loustalet's (2009) findings suggested that students' attitudes toward mathematics were related to their achievement level and not their gender. Loustalet's (2009) findings supported findings by Denissen et al. (2007) and Eccles et al. (1989, 1983) suggesting a relationship between attitudes and achievement.

Kutch (2011) conducted a study with seventh and eighth grade students from a suburban school in Delaware to determine if integrating mathematics and science instruction in such a way that requires students to use these skills and concepts to solve engineering problems would increase students' desire and willingness to enroll in future courses. Additionally, Kutch (2011) studied interest levels in science, technology, engineering, and mathematics by giving students a pre- and post-survey to determine if interests changed over time as students integrated mathematics and science to solve engineering problems. Kutch (2011) modified an existing survey from the 4 Schools for Women in Engineering project created by STEMteams. Kutch (2011) found that initial STEM career interest was low for seventh grade students. Post-survey responses for seventh grade students showed little increase in STEM career interest for both the control group and the treatment group receiving integrated mathematics and science instruction. On the other hand, Kutch (2011) found a significant change in overall attitudes toward science for seventh grade students enrolled in the integrated mathematics and science course. Specifically, the seventh grade students enrolled in the integrated course reported increases in relevance and confidence toward science. Similar to the seventh grade students, Kutch (2011) found initial STEM career interest was low for eighth grade students. Also similar to the seventh grade students, the eighth grade students showed little increase in STEM career interest on the post-survey. Kutch (2011) found similar results for overall attitudes toward science for the eighth grade students enrolled in the integrated mathematics and science course. Eighth grade students in the treatment group reported that they were more likely to take science courses in high school than those not enrolled in the integrated mathematics and science course. The eighth grade treatment group also found science to be more relevant after being enrolled in the integrated mathematics and science course.

Additionally, Kutch (2011) found “little overall difference between the control and treatment groups in attitudes towards mathematics in the seventh grade” (p. 96). However, this was not the case for the eighth grade students. Kutch (2011) found significant changes in attitude with the treatment group. Eighth grade students enrolled in the integrated mathematics and science course were more likely to consider a career in mathematics, find mathematics to be useful, and feel more capable with mathematics. Kutch (2011) found increased interest in engineering with the seventh grade students enrolled in the integrated mathematics and science course. Seventh grade students enrolled in the integrated class showed increased interest in future courses related to engineering and in pursuing careers involving engineering. Kutch (2011) found less of an impact on the eighth grade students enrolled in the integrated course. However, she did find a significant difference for eighth grade students enrolled in the integrated course with the following statements, “A degree in engineering will allow me to get a good job” and “I am not interested in any career that uses math and science” (p. 100).

Overall, Kutch’s (2011) findings supported findings by BHEF (2007), the Business Roundtable (2005), U.S. Department of Education (2000), and the Executive Office of the President (2010) showing initial interest in STEM subjects and careers to be low. Additionally, Kutch’s (2011) findings also support findings by BHEF (2007), the Business Roundtable (2005), U.S. Department of Education (2000), and the Executive Office of the President (2010) showing initial attitudes toward STEM fields and subjects to be low. On a positive note, Kutch (2011) found significant increases in attitudes and interest in several STEM areas once students experienced an integrated mathematics and science course.

Medeiros (2011) conducted a study to examine differences in student attitudes toward mathematics and science students enrolled in two corporate STEM programs. Medeiros (2011) was specifically interested in examining gender differences in attitudes toward mathematics and science. Medeiros (2011) used mathematics and science attitudinal scales of over 300 13-19 year old students from across the US to determine if pre-course attitudes changed by the end of the program. Corporate programs used in the study were Raytheon's Stand and Deliver Corporate Campus Mentoring program and Raytheon's MathMovesU Day. Medeiros (2011) found post-program attitudes toward mathematics and science to be higher than pre-program attitudes in all attitudinal subscales except "personal confidence in math and attitudes towards success in math" (p. 55). Of great importance, Medeiros (2011) found that females have more positive attitudes than males "at the start of the program about women's role in the math domain" (p. 59). Additionally, Medeiros (2011) found females to have "more positive attitudes about being perceived as successful in math, and in science, as well as in the usefulness of science in their current and future lives" (p. 59). These findings contradicted findings by BHEF (2007), the Business Roundtable (2005), U.S. Department of Education (2000), and the Executive Office of the President (2010) that showed males, generally speaking, have more positive attitudes toward mathematics and science than did their female peers.

LeGrand (2013) conducted a study to examine the differences in mathematics and science attitudes and interest levels among fourth and fifth grade, seventh and eighth grade, and eleventh and twelfth grade students, specifically analyzing any attitudes and interest differences between genders. LeGrand's (2013) study consisted of 136 participants from a small semi-rural school district in Massachusetts. LeGrand's (2013) participants were administered a survey to determine levels of anxiety, confidence, value, enjoyment, and motivation in mathematics and science" (p. 50). LeGrand (2013) found that males were significantly more interested in science than females, and males expected to perform better than females in both mathematics and science. LeGrand (2013) also found that middle and high school males were more confident in their science abilities than were middle and high school females. When looking at career interests, LeGrand (2013) found that middle and high school males showed greater interests than middle and high school females in physical science careers. Lastly, LeGrand (2013) found that girls in elementary school were less likely to feel comfortable with mathematics and science classes compared to elementary age boys. Overall, LeGrand's (2013) findings showed a disparity between male and female student attitudes, interests, expectancies to perform well, and confidence in mathematics and science. LeGrand's findings aligned with research conducted by BHEF (2007), the Business Roundtable (2005), U.S. Department of Education (2000), and the Executive Office of the President (2010).

Colorado (2014) conducted a study to examine the relationship between motivation and achievement, specifically with mathematics. Colorado (2014) surveyed 97 high achieving fifth grade mathematics students in a suburban school district in the southeast region of the United States. Colorado (2014) administered a self-report inventory to determine a child's academic intrinsic motivation. Class grades and results from a gifted mathematics achievement test were then compared to the child's academic intrinsic motivation level. Colorado (2014) found a wide range of motivation levels with the average motivation level on the positive end. Colorado found no significant academic intrinsic motivation difference between genders. Colorado's (2014) findings conflicted with previous research that found a difference in motivation between boys and girls, especially in the area of mathematics (BHEF, 2007; Business Roundtable, 2005; U.S. Department of Education, 2000; Executive Office of the President, 2010). Equally surprising, Colorado (2014) did not find a correlation between academic intrinsic motivation and achievement, including between genders. This finding also contradicted research by Denissen et al. (2007) and Eccles et al. (1989, 1983). It should be noted that Colorado's (2014) study focused on high-achieving students and therefore her findings may not reflect the general elementary population.

Miller (2015) conducted a study with fourth and fifth grade students in a small school district outside of Harrisburg, Pennsylvania to determine if there was a relationship between elementary age students' attitudes toward mathematics and science and their opportunity to learn mathematics and science. Miller (2015) noted the continued trend that students were uninterested in pursuing science careers due to their unfavorable attitudes toward science. During the study, Miller (2015) surveyed students to determine their attitudes toward mathematics and science. The results of the study aligned with research by Legrand (2013) and Kutch (2011) and supported previous reports by the Executive Office of the President (2010), BHEF (2007), Business Roundtable (2005), and U.S. Department of Education (2000) that have indicated students have negative attitudes toward science. Miller (2015) believed students had an unfavorable attitude toward science due to the decreased opportunity to learn science. Miller (2015) recommended increasing the opportunity to learn science as a way to increase student attitudes toward science.

Rehmat (2015) conducted a study with 98 fourth grade students from a large school district in the Southwest region of the United States. The participants in Rehmat's (2015) study consisted of two groups, a treatment group and a control group. Each group was administered a STEM interest survey. The treatment group received problem-based learning (PBL) instruction for six weeks while the control group received traditional instruction from a popular textbook during the same time. Rehmat (2015) found that fourth grade students in both groups, treatment and control, had slightly positive attitudes with the pre-STEM interest survey. The control group had an average pre-STEM score of 136.15 out of 185, and the treatment group had an average pre-STEM score of 135.00. The post-STEM interest survey indicated that students who received PBL instruction had significantly increased positive attitudes toward STEM compared to the control group. The control group had an average post-STEM score of 142.61 (6.46 growth) while the treatment group had an average post-STEM score of 155.98 (20.98 growth). The results from Rehmat's (2015) study indicated that student attitudes toward STEM subjects could be significantly increased using PBL instruction. Rehmat's finding was important to note since research indicated that students are traditionally uninterested in STEM subjects (BHEF, 2007; Business Roundtable, 2005; U.S. Department of Education, 2000; Executive Office of the President, 2010).

Smith (2015) conducted a study to determine if negative attitudes toward science among fourth, fifth, and sixth grade Black students in three New Jersey Title I funded schools could be improved through out-of-school experiences with STEM-related programs. Smith (2015) examined research that indicated Black students "harbor negative feelings of self-efficacy in doing science, exhibit negative attitudes about science-related issues and science related careers” (p. 6). However, his findings neither supported nor contradicted the literature. The results from Smith’s (2015) study indicated feelings of neutrality toward science among Black students. “Pre- and post-attitude Likert mean subscale scores fell within a neutral 3.0 to 4.0 favorable range” (p. 128) for Black students who participated in out-of-school experiences and students who did not participate in out-of-school experiences. Smith (2015) found no statistical difference in student attitudes toward science between fourth, fifth, and sixth grade Black students who participated in out-of-school STEM experiences and students who did not participate in out-of-school STEM experiences. Due to out-of-school STEM experiences having no impact on student attitudes, Smith (2015) recommended school districts create “better education conditions for marginalized students in the sciences” (p. 135).

Project Lead the Way

Project Lead the Way (PLTW) (2014d) offers five “activity-, project-, and problem-based” (para. 1) K-12 STEM programs. Launch is designed for students in kindergarten through fifth grade. Along with building STEM knowledge and applying STEM skills, PLTW (2014i) Launch is designed to be an engaging curriculum that builds confidence in young learners and increases their interest in STEM education. Gateway is a program designed for middle school students with modules in engineering and biomedical science (PLTW, 2014h).

At the high school level, PLTW (2014d) provides three individual programs. Engineering is the company’s flagship program where high school students are expected to apply “engineering, science, math, and technology to solve complex, open-ended problems in a real world context” (PLTW, 2014g, para. 1). Biomedical Science immerses high school students into real world scenarios such as a mysterious death that crime scene investigators need to solve (PLTW, 2014e). Lastly, Computer Science is offered for high school students as a three-course program with an introductory, foundational, and specialty course (PLTW, 2014f).

PLTW programs were being implemented in all 50 states with increased participation from its inception in 1997 (PLTW, 2014j). PLTW (2014c) claims that students who participate in their programs have higher achievement and more positive attitudes toward STEM subjects than students who do not participate in PLTW. The following section is a review of studies related to PLTW and its effects on student attitudes and achievement.

Bottoms and Anthony (2005) conducted a study of “274 students who participated in the 2004 HSTW (High School that Works) Assessment” (p.3) and reported completion of at least two PLTW courses to determine if PLTW participation led to higher achievement and learning experiences than non-PLTW participating students within the HSTW network. Bottoms and Anthony (2005) created two comparison groups of equal distribution. “For both comparison groups – high tech fields and all career/technical students – two random samples of 274 students were drawn to match the demographics of the 274 PLTW students” (Bottoms & Anthony, 2005, p. 3). Bottoms and Anthony (2005) found that the PLTW group had significantly higher mathematics, reading, and science scores measured by the NAEP assessment than did the comparison groups. Additionally, Bottoms and Anthony (2005) found that the PLTW group completed more advanced level mathematics and science courses, were enrolled in courses that integrated reading and writing, were involved in more real-world problems, and completed more project assignments than did the comparison groups. Bottoms and Anthony's (2005) findings suggested that participation in PLTW improves academic achievement in mathematics, reading, and science. When connecting these findings with those of Denissen et al. (2007) and Eccles et al. (1983, 1989), one might conclude that the increased academic achievement seen in PLTW students could lead to higher levels of self-concept, value/importance, and interest.

Paslov (2006) conducted a study in Connecticut to determine if PLTW curriculum increased middle school student interest and achievement in mathematics. Paslov (2006) was particularly interested in determining if there was a difference in interest and achievement in mathematics between genders after PLTW implementation. Paslov's (2006) study consisted of a control group of 99 eighth grade students and a treatment group of 80 eighth grade students. The control group participated in the school's regular middle school schedule while the treatment group added a yearlong PLTW course. Both groups were administered a pre- and post- Fennema-Sherman Mathematics Attitude Scales (FSMAS), a pre- and post- Blue Ribbon Testing© assessment, the Connecticut benchmark assessment, and participated in student focus groups. Paslov (2006) found that "students collectively exposed to the pilot curriculum, PLTW, showed improvement in achievement as compared to students who were not exposed to PLTW" as measured by Blue Ribbon Testing© (p. 90). Additionally, Paslov (2006) found no difference in achievement between genders. In other words, both males and females showed equal growth in achievement after PLTW implementation. Paslov's (2006) "data analysis indicated that curriculum did not significantly impact students' attitudes towards mathematics when data were aggregated to include males and females" (p. 102) as measured by the FSMAS. While the FSMAS showed no significant difference, interviews with student focus groups revealed a different conclusion. “Proportionately, the students in the experimental group, in the aggregate of males and females, indicated either a like or love of mathematics (67%) at a two-to-one ratio over the students in the control group (32%)” (Paslov, 2006, p. 102).

Rogers (2006) conducted a study in the state of Indiana to determine if Indiana high school teachers perceived PLTW to be an effective program “in developing pre-engineering competencies” (p. 67). Rogers (2006) developed a survey instrument that was administered to 76 technology education teachers in the state of Indiana. Participants in Rogers’ (2006) study had completed PLTW professional development at Purdue University and were “currently teaching PLTW courses in Indiana” (p. 69). Rogers (2006) reported, “The respondents indicated that the PLTW curriculum is effective in developing student competency in pre-engineering” (p. 70). The results of Rogers’ (2006) study indicated, at least in Indiana, that teachers perceived PLTW to be an effective program. Rogers’ (2006) findings add to Bottoms and Anthony’s (2005) findings showing not only is the program effective in improving academic achievement, but trained PLTW teachers also perceived PLTW as an effective program.

Bottoms and Uhn (2007) conducted a comparative study of 292 PLTW enrolled students and 292 non-PLTW enrolled students to determine if PLTW enrolled students had higher mathematics, reading, and science NAEP scores, were more likely to (a) take four years of college mathematics and three years of college science, (b) complete HSTW-recommended curriculum, (c) experience more rigorous instruction, (d) have richer classroom experiences, and (f) have plans of pursuing postsecondary education than non-PLTW enrolled students. Bottoms and Uhn (2007) defined a PLTW enrolled student as someone who had completed at least three PLTW credits. Bottoms and Uhn (2007) used career and technical students from similar fields to form their first comparison group. The second comparison group was formed using career and technical students from all career and technical fields. Through random sampling, Bottoms and Uhn (2007) were able to match the demographics of the PLTW enrolled group with the non-PLTW group. Bottoms and Uhn (2007) reported six key findings. First, PLTW enrolled students "achieved significantly higher scores in mathematics and science on the NAEP-referenced HSTW Assessment" than non-PLTW enrolled students (Bottoms & Uhn, 2007, p. 3). Second, PLTW enrolled students were significantly more likely to "complete at least four years of mathematics – including Algebra I, geometry, Algebra II and one higher-level mathematics course – and at least three years of lab-based science courses during high school" than non-PLTW enrolled students (Bottoms & Uhn, 2007, p. 3). Third, PLTW enrolled students were significantly more likely to "complete all parts of the HSTW-recommended curriculum" than non-PLTW enrolled students (Bottoms & Uhn, 2007, p. 3). Fourth, PLTW enrolled students were significantly more likely to "experience engaging instructional practices in language arts, mathematics, and science courses" than non-PLTW enrolled students (Bottoms & Uhn, 2007, p. 3). Fifth, PLTW enrolled students were significantly more likely to "use academic knowledge and skills – reading, mathematics and science – to complete authentic assignments in their career/technical courses" than non-PLTW enrolled students (Bottoms & Uhn, 2007, p. 3). Lastly, PLTW enrolled students were significantly more likely to "perceive high school as important in preparing them for the future" than non-PLTW enrolled students (Bottoms & Uhn, 2007, p. 3).

Wheeler (2008) conducted a study to determine if two PLTW courses, Principles of Engineering and Introduction to Engineering Design, significantly increased mathematics achievement with high school sophomores. Wheeler's (2008) study consisted of two groups, a treatment group that took PLTW coursework and a control group that did not take PLTW coursework. Wheeler's (2008) sample consisted of 1,337 students, primarily White, from a suburban school district outside of Kansas City, Missouri. Wheeler (2008) compared eighth grade Missouri state assessment scores to tenth grade Missouri state assessment scores for both groups to determine if PLTW coursework significantly increased achievement compared with students who did not take PLTW coursework. Wheeler (2008) controlled for initial mathematics skill level using the eighth grade Missouri state assessment. Wheeler (2008) found no significant difference in mathematics achievement between the PLTW treatment group and the non-PLTW control group. Wheeler's (2008) findings are in contrast to Bottoms and Anthony (2005), Paslov (2006), and Bottoms and Uhn's (2007) findings which all revealed significant mathematics improvement due to PLTW coursework.

Kingsbury Center at Northwest Evaluation Association (KCNWEA) (2010) conducted a comparison study to determine if students enrolled in PLTW courses "demonstrated rates of academic growth in reading, mathematics, or the sciences that differ from the growth exhibited by comparable non-participating students" (p. 11). Additionally, KCNWEA (2010) wanted to determine the growth achieved by PLTW students in the three identified subjects was significantly different from non-participating students within the same school. KCNWEA's (2010) sample consisted of 951 students in seventh through twelfth grades from 22 schools in 10 states. To determine achievement level, KCNWEA used the 2008 fall and 2009 spring "Northwest Evaluation Association's Measures of Academic Progress (MAP) in reading, mathematics, general science, and science concepts" (KCNWEA, 2010, p. 12). KCNWEA (2010) found that academic growth by PLTW students in general science and reading was "essentially equivalent" (p. 13) to the matched non-participating students. However, KCNWEA (2010) found that PLTW students "showed academic growth that exceeded the growth" (p. 13) of matched non-participating students in science concepts and mathematics domains. Important to note, KCNWEA (2010) achieved almost identical results when looking at differences at the school level. KCNWEA (2010) suggested that "significant improvements in growth associated with PLTW participation were not attributed to school level characteristics" (p. 15). KCNWEA's (2010) findings supported findings by Bottoms and Anthony (2005) and Bottoms and Uhn (2007) that PLTW significantly affected mathematics and science achievement. KCNWEA's (2010) findings also supported findings by Paslov (2006) showing increased mathematics achievement. However, KCNWEA's findings disagreed with the findings of Bottoms and Anthony (2005) that PLTW significantly affected reading achievement.

Tran and Nathan (2010) conducted a study to determine if PLTW coursework had a significant impact on mathematics and science achievement. The sample for this study consisted of 70 tenth grade students from a Midwestern city who had participated in at least one PLTW course and a matched sample of 70 tenth grade students from the same community who had similar starting mathematics and science achievement, gender, and free or reduced lunch status. Eighth grade mathematics and science state assessment scores were used as baseline achievement data. Tenth grade mathematics and science state assessment scores were used to compare with the baseline achievement data. Tran and Nathan (2010) controlled for prior achievement using the eighth grade state assessment scores. Tran and Nathan (2010) found that when controlling for prior achievement, students enrolled in PLTW coursework tended to have less growth from eighth grade to tenth grade than the comparison group in both mathematics and science. Tran and Nathan's (2010) findings supported Wheeler's (2008) findings that PLTW does not significantly affect mathematics achievement. Like Wheeler's (2008) findings, Tran and Nathan's (2010) findings contradicted findings by Bottoms and Anthony (2005), Paslov (2006), Bottoms and Uhn (2007), and KCNWEA's (2010) findings.

Martin (2011) conducted a study at a large high school in the United States to determine the effects of "K-12 outreach initiatives and their ability to inspire students enrolled in Project Lead the Way high school pre-engineering courses to study engineering" (p. ii). Martin (2011) was specifically interested in the effects on Black students enrolled in PLTW and limited his study to include only Black students. Martin's (2011) study consisted of 76 freshmen through senior Black students who were enrolled in PLTW coursework. Martin (2011) modified a survey instrument that was developed to collect data on "demographics, prior engineering experiences, and prior engineering influences" (p. 53). Martin (2011) also used the Motivated Strategies for Learning Questionnaire designed to measure engineering self-efficacy. Using an intercorrelation analysis, Martin (2011) found that interest in engineering for Black students was highest at the lowest grade levels. Martin (2011) also found that Black students with more engineering experience had higher levels of self-efficacy in their PLTW coursework. Martin's (2011) findings aligned with the Business Roundtable (2005) and the Executive Office of the President (2010) reports that formally suggested the need for increased STEM exposure for U.S. students. Furthermore, Martin (2011) found that middle school and high school PLTW exposure and parental encouragement were leading influences for Black students to study engineering. Parental encouragement was also important to note as the Business Roundtable (2005) report recommended the need to "launch a campaign to help parents, students, employees and community leaders understand why math and science are so important to individual success and national prosperity" (p. 10).

Schenk et al. (2011) conducted a study in the state of Iowa to determine the impact PLTW had on mathematics and science achievement. Schenk et al. (2011) hypothesized that PLTW enrolled students would have higher achievement scores in mathematics and science than students not enrolled in PLTW courses. Additionally, Schenk et al. (2011) was interested in gathering descriptive statistics to determine what types of students enrolled in PLTW courses. Schenk et al. (2011) had a sample size of 26,030 students. The authors found a strong selection bias for PLTW enrolled students. Descriptive statistics revealed, "Participants were disproportionately white male and 91 percent of the participants were white" (Schenk et al, 2011, p. 13). Additionally, Schenk et al. (2011) found that "PLTW participants were less likely to come from low-income families" (p. 13). Lastly, Schenk et al. (2011) found that students who took PLTW courses had "higher achievement in mathematics and science than non-PLTW participants prior to entering the program" (p. 13). Due to the strong selection bias, Schenk et al. (2011) used "nearest neighbor," "one-to-one matching with genetic algorithms," and "one-to-two matching with genetic algorithms" to develop matched groups and control for pre-existing achievement (pp. 16-17). Schenk et al. (2011) found "statistically significant evidence that PLTW increases mathematics or science scores" (p. 2). Schenk et al.'s (2011) findings supported the findings of Bottoms and Anthony (2005) and Bottoms and Uhn (2007) that PLTW significantly affects mathematics and science achievement. Schenk et al.'s (2011) findings also supported findings by Paslov (2006) showing increased mathematics achievement.

Van Overshelde (2013) conducted a longitudinal study of more than 5,000 students in the State of Texas to determine if students who had experienced two or more PLTW courses had higher test scores on the grade 11 Texas mathematics assessment than students who had no experiences with PLTW. Van Overshelde (2013) used propensity score matching "to statistically match the PLTW students with non-PLTW students and a number of variables were included in the matching process that are known to be associated with academic success, including their scores on the state's Grade 8 mathematics assessment" (p. 6). Van Overshelde (2013) found a significant difference in grade 11 mathematics scaled scores as students who participated in PLTW "had a significantly higher mean scale score than the matched control group" (p. 13). Statistically greater achievement scores in "meeting the minimum state standard" and "meeting the college-ready standard" were also noted (Van Overshelde 2013, p. 13). He also found that students who participated in PLTW were significantly more likely to attend an institution of higher education following high school graduation than the matched control group. Van Overshelde's (2013) findings of increased achievement for

PLTW students were promising as Denissen et al. (2007) and Eccles et al. (1989, 1983) found a reciprocal relationship between achievement and self-concept.

Summary

Chapter two provided a literature review pertinent to this study. STEM education was examined revealing a need for the US to improve student attitudes and increase student achievement with STEM education. Student attitudes, specifically self-concept, value/importance, and interest, were of importance as evidence suggests a reciprocal relationship between attitudes and achievement. Project Lead the Way was primarily shown to have significant effects on student attitudes and achievement. However, the literature specifically pertaining to PLTW Launch and elementary students was non-existent. Described in chapter three is the methodology used in this study, including research design, population and sample, sampling procedures, instrumentation, data collection procedures, data analysis and hypothesis testing, and limitations.

Chapter Three

Methods

The first purpose of this study was to determine if there was a difference in fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology before and after implementation of PLTW Launch. Due to the current gender gap in STEM fields, data were subsequently analyzed to determine if the change in self-concept, value/importance, and interest significantly differed between males and females. Additionally, PLTW Launch designed modules for specific grade levels but also allows teachers and schools the autonomy to use their discretion and choose modules from other grade levels. The third purpose of this study was to determine if the change in self-concept, value/importance, and interest in mathematics, science, and technology was affected by the selected STEM units taught (PLTW recommended vs. teacher recommended).

In this chapter, the methodology utilized to conduct the study is presented. The first three sections outline the research design, identify the population and sample, describe the sampling procedures, and identify the instrumentation used in the study. The final three sections include the data collection procedures, the data analysis and hypothesis testing, and the limitations of the study.

Research Design

In this quasi-experimental study, an alternative treatment pretest-postest with nonequivalent groups design was used (Creswell, 2014). Survey research, using a modified survey from the University of Michigan's Childhood and Beyond project (Gender & Achievement Research Program, 2015c) was used to collect ordinal scale data to determine the extent of change in fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology after PLTW Launch implementation. Subsequently, ordinal scale data from the same modified survey was used to determine if the change in students' self-concept, value/importance, and interest in mathematics, science, and technology was significantly different between genders and selected STEM units taught after PLTW Launch implementation.

The independent variables for this study were PLTW Launch implementation, selected STEM units, and gender. The dependent variables included in the study were students' changes in self-concept, value/importance, and interest in mathematics, science, and technology. The independent variables in the study were gender and PLTW recommended modules vs. teacher recommended modules as measured before and after PLTW Launch implementation. It should be noted that PLTW recommends that fifth grade students participate in (1) Robotics and Automation, (2) Robotics and Automation: Challenge, (3) Infection: Detection, and (4) Infection: Modeling and Simulation (Project Lead the Way, 2014k). Due to teacher discretion, Center Elementary students did not participate in all of the PLTW recommended fifth grade modules. Instead, that group of students participated in Stability and Motion: Science and Flight, Stability and Motion: Forces and Interaction, Robotics and Automation, and Robotics and Automation: Challenge (S. Rose, personal communication, May 3, 2016). The first two modules, Stability and Motion: Science and Flight and Stability and Motion: Forces and Interaction, are considered third grade modules (Project Lead the Way, 2014k). Therefore, Center Elementary students did not receive all four PLTW fifth grade recommended modules. The students from Red Bridge Elementary participated in all four PLTW fifth grade recommended modules (M. Fritz, personal communication, May 3, 2016).

Population and Sample

The population for this study was limited to fifth grade students in one school district in an urban setting in Missouri. The non-equivalent sample for this study was fifth grade students from Center Elementary and Red Bridge Elementary in the Center School District. The two elementary schools were selected because they chose to implement PLTW Launch at the fifth grade level during the 2015-2016 school year. Both schools have two sections of fifth grade. The fifth grade students from Center Elementary and Red Bridge Elementary made up 53.7% of the total district fifth grade population. The sample was heterogeneous in nature and contained special education students, English Language Learner students, minority students, and students receiving free or reduced lunch.

Sampling Procedures

Purposive sampling was used for this study. Purposive sampling "involves selecting a sample based on the researcher's experience or knowledge of the group to be sampled" (Lunenburg & Irby, 2008, p. 175). The sample was specifically chosen, as these were the only two schools that implemented PLTW Launch in fifth grade during the 2015-2016 school year. A student was included in the sample if the following criteria were met:

1. The student was enrolled in the fifth grade at Center Elementary or Red Bridge Elementary during the 2015-2016 school year in the Center School District;

2. Math Science Technology (MST) survey was completed before PLTW Launch implementation; and
3. The student completed the post-MST survey after PLTW Launch implementation.

Instrumentation

The Childhood and Beyond Wave 5 survey (Gender & Achievement Research Program, 2015c), designed by Eccles from the University of Michigan's Childhood and Beyond project, was modified and used in this study. Items from the Wave 5 survey were selected to determine the sample's self-concept, value/importance, and interest in mathematics, science, and technology (Gender & Achievement Research Program, 2015c). See Appendix B for the original Wave 5 survey. The survey was created for the Childhood and Beyond project that began in 1987 and continued through 1999 (Gender & Achievement Research Program, 2015d). The project was a longitudinal, cross-sectional study with data collection beginning in 1987 (Gender & Achievement Research Program, 2015a, 2015b). Various surveys were created for the project (Gender & Achievement Research Program, 2015a). Eccles granted permission to use and modify surveys created for the Childhood and Beyond project. The instrument created for Wave 5 was selected, and modifications were made to the survey.

The Wave 5 survey was selected for three reasons. First, the Childhood and Beyond project and the Wave 5 survey aligned with the research questions and variables for this study. The Wave 5 survey had items that specifically addressed self-concept, value/importance, and interest (Denissen et al., 2007; Wigfield et al., 1997). Second, the Wave 5 survey was adaptable. Eccles designed each of the surveys in such a way that areas of focus could be modified, keeping the items similar. For example in the question, “How much do you like doing math?,” the mathematics domain could be removed and replaced with another domain, such as science or technology (see Appendix B). Third, the format of the Wave 5 survey was age appropriate for the sample. The readability and understanding of the question matched the sample (Gender & Achievement Research Program, 2015c).

Four modifications were made to the Wave 5 survey. First, items from the mathematics section were used with all other items excluded from the modified survey. Second, the word “math” was substituted with either “science” or “technology” to create two additional sections. Third, items 12, 13, 15, 16, and 17 in the Wave 5 mathematics section were removed from the modified survey because they did not measure self-concept, value/importance, or interest (see Appendix B). Fourth, a description of technology at the beginning of the technology section was included to ensure participants used the same definition for technology. See Appendix C for the directions listed before the technology section in the modified survey.

Measurement. The survey consisted of three sections that examined a specific academic domain: mathematics, science, and technology. Within each academic domain, self-concept, value/importance, and interest were used to determine if a change existed after PLTW Launch implementation. Staying consistent with portions of Eccles’ Wave 5 survey, a 7-point semantic differential ordinal scale was used for each item with one being the lowest score and seven being the highest score (see Appendix C for MST Survey) (Denissen, Zarrett, & Eccles, 2007; Wigfield et al., 1997). Anchors that aligned with the wording of the item were placed below 1, 4, and 7. For example, the following anchors were used for the item "In general, I find working on math assignments:" "1 - *Very boring,"* "4 – *O.K.*," and "7 – *Very interesting* (*very fun*)." The answers provided the ordinal data for use in this study. Each section consisted of 13 items numbered 1 through 13. Items 1-5 of each section measured the students' self-concept for RQ1 and RQ4.

1. How good at (domain) are you?
2. Compared to most of your other activities, how good are you at (domain)?
3. If you were to list all of the students in your grade from the worst to the best in (domain), where would you put yourself?
4. How well do you expect to do in (domain) next year?
5. How good would you be at learning something new in (domain)?

   (Gender & Achievement Research Program, 2015c),

To determine a self-concept score for each domain, responses to survey items 1-5 were added. The self-concept score for each domain could range from 5 to 35. The change in self-concept was calculated by subtracting the self-concept pre-implementation survey total from the self-concept post-implementation survey total. The change in value/importance for each domain could range from 0 to 30.

Items 6-9 of each section measured the students' value/importance for RQ2 and RQ6.

6. In general, how useful is what you learn in (domain)?
7. Compared to most of your other activities, how useful is what you learn in (domain)?
8. For me, being good at (domain) is?

9. Compared to most of your other activities, how important is it to you to be good at (domain)? (Gender & Achievement Research Program, 2015c)

To determine a value/importance score for each domain, responses to survey items 6-9 were added. The value/importance score for each domain could range from 4 to 28. The change in value/importance was determined by subtracting the value/importance pre-implementation survey total from the value/importance post-implementation survey total. The change in value/importance for each domain could range from 0 to 24.

Items 10-13 of each section measured the students' interest for RQ3 and RQ8.

10. How much do you like doing (domain)?
11. Compared to most of your other activities, how much do you like (domain)?
12. In general, I find working on (domain) assignments to be.

    How often do you wish you were doing something else when you do (domain)? (Gender & Achievement Research Program, 2015c)

To determine an interest score for each domain, responses from survey items 10-13 were added. The interest score for each domain could range from 4 to 28. The change in interest was determined by subtracting the interest pre-implementation survey total from the interest post-implementation survey total. The change in interest for each domain could range from 0 to 24.

Validity and reliability. Eccles' Wave 5 survey, along with the other surveys developed for the Childhood and Beyond project, was documented for validity and reliability in multiple studies (Denissen et al., 2007; Eccles, O'Neil, & Wigfield, 2005; Sainz & Eccles, 2011; Simpkins et al., 2006). The Wave 5 survey, along with the other Childhood and Beyond project surveys, was designed in a such a way that modifications to the specific domain could be made without affecting the survey's validity and reliability (Eccles et al., 2005). A valid and reliable survey is maintained even when the researcher substitutes domains (Eccles et al., 2005).

The Wave 5 survey was analyzed for face, discriminant, and predictive validity. The team concluded that the face validity was high due to the linguistic overlap between items. Factor analytic results indicated the discriminant validity of the scales (Eccles et al., 2005). Finally, predictive validity was confirmed "by the expected gender differences and developmental declines in each scale, the expected relations of the scales to both parent and teacher ratings, and the expected relations of the scales to each other" (Eccles et al., 2005, p. 245).

To determine reliability, Eccles and her team ran factor analyses to determine if elementary aged children had good psychometric properties and were comparable to previous analyses done by her team with adolescents (Eccles et al., 2005; Wigfield et al., 1997). Within the math domain, Eccles' team found similar factors for children as young as first grade. Item analysis indicated scales that were "good to excellent, with Cronbach's alphas ranging from .53 to .82 (Eccles et al., 2005, 244-245). Cronbach's alpha was computed to compare the reliability of the science and technology items. Further alphas were provided on the Childhood and Beyond project website specific to the Wave 5 survey. For math self-concept, the provided alpha was .92. For the math value/importance, the provided alpha was .84. For math interest, the provided alpha was .91 (Gender & Achievement Research Program, 2015d). All three subscales provided evidence of an internal consistency above Lunenburg and Irby's (2008) recommended .80 acceptable threshold.

In summary, the selected instrument was valid and reliable and remained valid and reliable even with the mentioned modifications (Eccles et al., 2005). Eccles et al. (2005) supported these modifications by designing an instrument that allowed domains to be substituted, keeping the wording and scoring system the same. “The wording of these items was essentially the same in each domain. All items in all domains were answered using response scales ranging from 1 to 7” (Eccles et al., 2005, p. 244). The selected survey allows the researcher to substitute the domains of science and technology in place of the mathematics domain.

Other variables. The variable gender (male, female) was utilized for RQ4, RQ6, and RQ8. The variable selected STEM units taught (PLTW recommended, teacher recommended) were utilized for RQ5, RQ7, and RQ9. Students attending Red Bridge Elementary were taught the PLTW recommended units. Students attending Center Elementary were taught the teacher recommended units.

Data Collection Procedures

Permission to use and modify the Childhood and Beyond project survey was granted by Eccles via an email from Banerjee on August 3, 2015 (see Appendix D). Permission to use archival data for this study was verbally granted by the superintendent of schools (S. Nibbelink, personal communication, September 18, 2015). An Institutional Review Board (IRB) for approval to conduct the study was submitted to Baker University on March 26, 2016 (see Appendix E). The University approved the IRB request on April 12, 2016 (see Appendix F). The Center School District administered the survey and collected the data during the 2015-2016 school year to determine if the newly implemented program had positive outcomes. To ensure confidentiality, school personnel downloaded the data into an Excel spreadsheet, replaced names and other identifying characteristics with codes, and shared the Excel file with the researcher via email. The Excel file was then downloaded by the researcher and stored in a password-protected Google Drive. The researcher was the only one with access to the file.

Data Analysis and Hypothesis Testing

Responses to each of the 39 survey items were analyzed using JASP 0.7.5.5 software to determine if students' self-concept, value/importance, and interest in mathematics, science, and technology significantly changed after PLTW implementation. Survey responses were also analyzed to determine if there was a significant difference between genders. Lastly, survey responses were analyzed to determine if there was a significant difference in self-concept, value/importance, and interest in mathematics, science, and technology between students who were taught the PLTW recommended units compared to students who were taught the teacher recommended units. The following research questions and hypotheses were established for this study. All research questions were measured using the scores from the student survey.

RQ1. To what extent is there a difference in fifth grade students' self-concept of mathematics, students' self-concept of science, and students' self-concept of technology as measured before and after implementation of Project Lead the Way Launch?

H1. There is a difference in fifth grade students' self-concept of mathematics, as measured before and after the implementation of Project Lead the Way Launch.

H2. There is a difference in fifth grade students' self-concept of science, as measured before and after the implementation of Project Lead the Way Launch.

H3. There is a difference in fifth grade students' self-concept of technology, as measured before and after the implementation of Project Lead the Way Launch.

RQ2. To what extent is there a difference in fifth grade students' value/importance of mathematics, value/importance of science, and value/importance of technology as measured before and after the implementation of Project Lead the Way Launch?

H4. There is a difference in fifth grade students' value/importance of mathematics, as measured before and after the implementation of Project Lead the Way Launch.

H5. There is a difference in fifth grade students' value/importance of science, as measured before and after the implementation of Project Lead the Way Launch.

H6. There is a difference in fifth grade students' value/importance of technology, as measured before and after the implementation of Project Lead the Way Launch.

RQ3. To what extent is there a difference in fifth grade students' interest in mathematics, interest in science, and interest in technology as measured before and after the implementation of Project Lead the Way Launch?

H7. There is a difference in fifth grade students' interest in mathematics, as measured before and after implementation of Project Lead the Way Launch.

H8. There is a difference in fifth grade students' interest in science, as measured before and after implementation of Project Lead the Way Launch.

H9. There is a difference in fifth grade students' interest in technology, as measured before and after implementation of Project Lead the Way Launch.

Paired-samples *t* tests were conducted to test H1-H9. The before implementation survey scores were compared to the after implementation survey scores to assess the change in self-concept in mathematics, science, and technology; value/importance in mathematics, science, and technology; and interest in mathematics, science, and technology. The level of significance was set at .05.

RQ4. To what extent is the change in fifth grade students' self-concept of mathematics, self-concept of science, and self-concept of technology, as measured before and after the implementation of Project Lead the Way Launch, affected by gender?

H10. The change in fifth grade students' self-concept of mathematics, as measured before and after the implementation of Project Lead the Way Launch, is affected by gender.

H11. The change in fifth grade students' self-concept of science, as measured before and after the implementation of Project Lead the Way Launch, is affected by gender.

H12. The change in fifth grade students' self-concept of technology, as measured before and after the implementation of Project Lead the Way Launch, is affected by gender.

RQ5. To what extent is the change in fifth grade students' self-concept of mathematics, self-concept of science, and self-concept of technology, as measured before and after implementation of Project Lead the Way Launch, affected by the selected STEM units taught (PLTW recommended vs. teacher recommended)?

H13. The change in fifth grade students' self-concept of mathematics, as measured before and after the implementation of Project Lead the Way Launch, is affected by the selected STEM units taught (PLTW recommended vs. teacher recommended).

H14. The change in fifth grade students' self-concept of science, as measured before and after the implementation of Project Lead the Way Launch, is affected by the selected STEM units taught (PLTW recommended vs. teacher recommended).

H15. The change in fifth grade students' self-concept of technology, as measured before and after the implementation of Project Lead the Way Launch, is affected by the selected STEM units taught (PLTW recommended vs. teacher recommended).

RQ6. To what extent is the change in fifth grade students' value/importance of mathematics, value/importance of science, and value/importance of technology, as measured before and after the implementation of Project Lead the Way Launch, affected by gender?

H16. The change in fifth grade students' value/importance in mathematics, as measured before and after the implementation of Project Lead the Way Launch, is affected by gender.

H17. The change in fifth grade students' value/importance of science, as measured before and after the implementation of Project Lead the Way Launch, is affected by gender.

H18. The change in fifth grade students' value/importance of technology, as measured before and after the implementation of Project Lead the Way Launch, is affected by gender.

RQ7. To what extent is the change in fifth grade students' value/importance of mathematics, value/importance of science, and value/importance of technology, as measured before and after the implementation of Project Lead the Way Launch, affected by the selected STEM units taught (PLTW recommended vs. teacher recommended)?

H19. The change in fifth grade students' value/importance of mathematics, as measured before and after the implementation of Project Lead the Way Launch, is affected by the selected STEM units taught (PLTW recommended vs. teacher recommended).

H20. The change in fifth grade students' value/importance of science, as measured before and after the implementation of Project Lead the Way Launch, is affected by the selected STEM units taught (PLTW recommended vs. teacher recommended).

H21. The change in fifth grade students' value/importance of technology, as measured before and after the implementation of Project Lead the Way Launch, is affected by the selected STEM units taught (PLTW recommended vs. teacher recommended).

RQ8. To what extent is the change in fifth grade students' interest in mathematics, interest in science, and interest in technology, as measured before and after the implementation of Project Lead the Way Launch, affected by gender?

H22. The change in fifth grade students' interest in mathematics, as measured before and after the implementation of Project Lead the Way Launch, is affected by gender.

H23. The change in fifth grade students' interest in science, as measured before and after the implementation of Project Lead the Way Launch, is affected by gender.

H24. The change in fifth grade students' interest in technology, as measured before and after the implementation of Project Lead the Way Launch, is affected by gender.

RQ9. To what extent is the change in fifth grade students' interest in mathematics, interest in science, and interest in technology, as measured before and after the implementation of Project Lead the Way Launch, affected by the selected STEM units taught (PLTW recommended vs. teacher recommended)?

H25. The change in fifth grade students' interest in mathematics, as measured before and after the implementation of Project Lead the Way Launch, is affected by the selected STEM units taught (PLTW recommended vs. teacher recommended).

H26. The change in fifth grade students' interest in science, as measured before and after the implementation of Project Lead the Way Launch, is affected by the selected STEM units taught (PLTW recommended vs. teacher recommended).

H27. The change in fifth grade students' interest in technology, as measured before and after the implementation of Project Lead the Way Launch, is affected by the selected STEM units taught (PLTW recommended vs. teacher recommended).

Two-sample *t* tests were conducted to test H10-H27. Two sample means were compared for each domain (mathematics, science, and technology). The level of significance was set at .05.

Limitations

Lunenburg and Irby (2008) define limitations as the factors in a research study that cannot be controlled. It is important to identify limitations as they "may have an effect on the interpretation of the findings or on the generalizability of the results" (p. 133). The following limitations were identified for the present study:

1. There was a national emphasis on instruction in STEM areas during this study. Due to this national emphasis, it was possible that the sample was exposed to additional STEM instruction. Therefore, changes in students' self-concept, value/importance, and interest cannot be exclusively attributed to PLTW Launch.
2. A teacher's personal beliefs and attitudes toward specific subjects could influence students' self-concepts, what students value and find important, and students' interests. Teachers who value STEM might naturally influence their students' STEM self-concepts, what students value and find important, and students' interests. Therefore, changes in students' self-concept, value/importance, and interest cannot be solely attributed to PLTW Launch curriculum.
3. PLTW Launch was a new curriculum during the study. Additions and omissions by Project Lead the Way, Inc. occurred during the first years of PLTW Launch. Therefore, the survey data for the study is time-bound to the 2015-2016 school year and should not be generalized beyond this date.
4. Professional development was limited to a train-the-trainer model. The teachers who implemented PLTW Launch for this study did not receive direct professional development from PLTW employees.

Summary

A one-group pretest-posttest nonequivalent control group design was used in this study (Lunenburg & Irby, 2008). Survey research, using the MST survey, which was a modification of a survey from the University of Michigan's Childhood and Beyond project, was used to collect data to determine the extent of change in fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology after PLTW Launch implementation. Subsequently, the MST survey was used to determine if the change in students' self-concept, value/importance, and interest in mathematics, science, and technology was significantly different between genders and selected STEM units taught after PLTW Launch implementation. The methodology used to conduct the study was described in this chapter. The research design was provided, the population and sample were identified, and sampling procedures were described. Instrumentation used for the study, along with measurement, validity, and reliability was explained. The procedures for data collection were detailed, and the data analysis and hypothesis testing was described. Lastly, the limitations of the study were presented. In chapter four, the results of the statistical analyses and hypothesis testing are provided.

Chapter Four

Results

The purpose of this study was to determine whether fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology changed as a result of participation in PLTW Launch. An additional purpose of this study was to determine whether the change in fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology changed after the participation in PLTW Launch was affected by student gender or the selected STEM units taught (PLTW recommended vs. teacher recommended). Provided in this chapter are the descriptive statistics for the sample and the results of the quantitative analysis for each of the hypotheses. Paired-samples *t* tests were conducted to address RQ1-RQ3. Two-sample *t* tests were conducted to address RQ4-RQ9.

Descriptive Statistics

Before the implementation of PLTW Launch, the MST survey was administered to 87 fifth grade students attending Center Elementary and Red Bridge Elementary. Of the 87 respondents who completed the before implementation survey, 44 students attended Center Elementary, and the remaining 43 respondents attended Red Bridge Elementary. After the implementation of PLTW Launch, the MST survey was administered to 78 of the 87 students who took the before implementation survey. Of the 78 respondents who completed the after implementation survey, 39 students attended Center Elementary, and 39 students attended Red Bridge Elementary. Nine students who completed the before implementation MST survey moved from the school district before the after implementation survey was administered. Responses for these nine students were discarded and not used in the data analysis resulting in a final study group size of 78 students.

Respondents to both the before implementation MST survey and the after implementation MST survey inadvertently left items unanswered. Instead of discarding the entire survey, these items were discarded leaving that domain (mathematics, science, and technology) and variable (self-concept, value/importance, and interest) of the MST survey void for that particular respondent. Therefore, the number of respondents per hypothesis varies depending on the number of completed MST pre- and post-treatment responses collected.

While no hypothesis testing was conducted, it should be noted that the sample studied generally had positive attitudes toward mathematics, science, and technology before and after PLTW Launch implementation. The before implementation self-concept mean for mathematics was 25.77 out of 35 and the after implementation self-concept mean for mathematics was 25.08 out of 35. Both means were more than 5-points higher than a neutral score of 20. The before implementation self-concept mean for science was 25.65 out of 35 and the after implementation self-concept mean for science was 27.17 out of 35. Again, both means were more than 5 points higher than a neutral score of 20. The before implementation self-concept mean for technology was 29.01 out of 35 and the after implementation self-concept mean for technology was 28.81 out of 35. As with mathematics and science, technology self-concept before and after implementation was more than 5 points higher than a neutral score of 20 indicating that students generally had a positive self-concept of mathematics, science, and technology.

The same was also found for value/importance of mathematics, science, and technology. The before implementation value/importance mean for mathematics was 22.53 out of 28 and the after implementation value/importance mean for mathematics was 22.24 out of 28. Both means were more than 5 points higher than what would be considered a neutral score of 16. The before implementation value/importance mean for science was 21.04 out of 28 and the after implementation value/importance mean for science was 21.36 out of 28. Again, both means were more than 5 points higher than a neutral score of 16. The before implementation value/importance mean for technology was 22.15 out of 28 and the after implementation value/importance mean for technology was 22.36 out of 28. As with mathematics and science value/importance, technology value/importance before and after implementation was more than 5 points higher than a neutral score of 16.

Like self-concept and value/importance, overall interest in mathematics, science, and technology was generally positive. The before implementation interest mean for mathematics was 19.20 out of 28 and the after implementation interest mean for mathematics was 19.36 out of 28. Both means were more than 3 points higher than what would be considered a neutral score of 16. The before implementation interest mean for science was 20.17 out of 28 and the after implementation interest mean for science was 21.03 out of 28. The before interest mean for science was more than 4 points higher and rose to over 5 points higher than what would be considered a neutral score of 16. The before implementation interest mean for technology was 22.09 out of 28 and the after implementation interest mean for technology was 22.20 out of 28. As with science interest, technology interest before and after implementation was more than 5 points higher than a neutral score of 16. Table 3 contains a summary of self-concept, value/importance, and interest before and after mean scores compared with the neutral and maximum scores.

Table 3

Self-Concept, Value/Importance, and Interest Mean Scores

Variable	Domain	Before	After	Neutral	Max
Self-concept	Mathematics	25.770	25.080	20	35
	Science	25.650	27.170	20	35
	Technology	29.010	28.810	20	35
Value/Importance	Mathematics	22.530	22.240	16	28
	Science	21.040	21.360	16	28
	Technology	22.150	22.360	16	28
Interest	Mathematics	19.200	19.360	16	28
	Science	20.170	21.030	16	28
	Technology	22.090	22.200	16	28

Other patterns among the data emerged that are important to note. Fifth grade students' self-concept of technology had the greatest before implementation mean score (29.01) and the greatest after implementation mean score (28.81). While the mean self-concept of technology score decreased after implementation, the after implementation mean was still more than 1.5 points higher than the after self-concept of science mean and 3.5 points higher than the after self-concept of mathematics mean. Overall, fifth grade students' self-concept of mathematics mean score, value/importance of mathematics mean score, and self-concept of technology mean score decreased after implementation. An important fact to note was the decrease for self-concept of mathematics after implementation was greatest among fifth grade females. However, the decrease in value/importance of mathematics and self-concept of technology after implementation was greatest among fifth grade males. See Table 4 for mean increase/decrease comparisons between genders. Additionally, one can see in Table 4 that fifth grade male scores had the greatest after implementation increases and least after implementation decreases in six of the nine areas as compared to fifth grade females.

Table 4

Mean Increase/Decrease after PLTW Launch Implementation by Gender

	Male Mean Increase/Decrease	Female Mean Increase/Decrease
SC mathematics	-0.543	-0.833
SC science	2.611	0.400
SC technology	-0.921	0.556
VI mathematics	-0.838	0.270
VI science	0.500	0.094
VI technology	-0.135	0.568
I mathematics	0.632	-0.316
I science	1.385	0.194
I technology	0.579	-0.378

Note. SC = Self-concept, VI = Value/Importance, and I = Interest

Last, fifth grade students at Red Bridge Elementary had after implementation decreases in three of the nine areas as opposed to fifth grade students at Center Elementary seeing decreases in five of the nine areas. See Table 5 for mean increase/decrease after implementation for Center Elementary and Red Bridge Elementary. Additionally, one can see in Table 5 that fifth grade students at Red Bridge Elementary saw the greatest after implementation increases and least after implementation decreases in six of the nine areas as compared to fifth grade students at Center Elementary. It is also interesting to note, fifth grade students at Red Bridge Elementary saw mean after implementation increases in self-concept of science, value/importance of science, and interest in science. Science was the only domain where an elementary school saw mean after implementation increases with all three dependent variables (self-concept, value/importance, & interest).

Table 5

Mean Increase/Decrease after PLTW Launch Implementation by School

	Center Elementary	Red Bridge Elementary
Self-concept mathematics	-1.971	0.474
Self-concept science	1.250	1.744
Self-concept technology	-0.371	-0.053
Value/Importance mathematics	0.057	-0.590
Value/Importance science	-0.281	0.838
Value/Importance technology	0.457	0.000
Interest mathematics	-0.324	0.615
Interest science	-0.206	1.861
Interest technology	0.611	-0.359

Hypothesis Testing

The following section includes the data analysis for RQ1-RQ9. Included in the data analysis for each hypothesis are the t statistic, degrees of freedom (df), and p value. Additionally, the sample mean(s) (M) and standard deviation (SD) are reported for RQ1-RQ9. However, it should be noted that the sample means reported for RQ4-RQ9 have the potential to be a negative mean. A negative mean would occur if the change in survey score from before implementation to after implementation had an overall decrease.

RQ1. To what extent is there a difference in fifth grade students' self-concept of mathematics, self-concept of science, and self-concept of technology as measured before and after implementation of Project Lead the Way Launch?

H1. There is a difference in fifth grade students' self-concept of mathematics, as measured before and after the implementation of Project Lead the Way Launch.

A paired-samples *t* test was conducted to test H1. The before implementation survey scores were compared to the after implementation survey scores to assess the change in self-concept of mathematics. The level of significance was set at .05. The results of the paired-samples *t* test indicated no statistically significant difference between the mean values, $t = 1.230$, $df = 70$, $p = 0.223$. As shown in Table 6, the sample mean for before PLTW implementation ($M = 25.77$, $SD = 5.499$) was not significantly different from the sample mean for after PLTW implementation ($M = 25.08$, $SD = 5.261$). The hypothesis was not supported by the data. On average, a student's self-concept of mathematics before and after PLTW implementation was not significantly different.

Table 6

Descriptive Statistics for the Results of the Test for H1

	M	*SD*	*N*
Before implementation	25.77	5.499	71
After implementation	25.08	5.261	71

H2. There is a difference in fifth grade students' self-concept of science, as measured before and after the implementation of Project Lead the Way Launch.

A paired-samples *t* test was conducted to test H2. The before implementation survey scores were compared to the after implementation survey scores to assess the change in self-concept of science. The level of significance was set at .05. As shown in Table 7, the results of the paired-samples *t* test indicated a statistically significant difference between the two values, $t = 2.864$, $df = 70$, $p = 0.006$. The sample mean for before PLTW implementation ($M = 25.65$, $SD = 5.246$) was significantly less than the sample mean for after PLTW implementation ($M = 27.17$, $SD = 5.113$). The hypothesis was supported by the data. On average, a student's self-concept of science before and after PLTW implementation was significantly different. The sample mean for after the implementation was higher than the sample mean before the implementation.

Table 7

Descriptive Statistics for the Results of the Test for H2

	M	*SD*	*N*
Before implementation	25.65	5.246	71
After implementation	27.17	5.113	71

H3. There is a difference in fifth grade students' self-concept of technology, as measured before and after the implementation of Project Lead the Way Launch.

A paired-samples *t* test was conducted to test H3. The before implementation survey scores were compared to the after implementation survey scores to assess the change in self-concept of mathematics. The level of significance was set at .05. As shown in Table 8, the results of the paired-samples *t* test indicated no statistically significant difference between the two values, $t = -0.301$, $df = 73$, $p = 0.764$. The sample mean for before PLTW implementation ($M = 29.01$, $SD = 5.597$) was not significantly different from the sample mean for after PLTW implementation (*M* = 28.81, *SD* = 4.959). The hypothesis was not supported by the data. On average, a student's self-concept of technology before and after PLTW implementation was not significantly different.

Table 8

Descriptive Statistics for the Results of the Test for H3

	M	*SD*	*N*
Before implementation	29.01	5.597	74
After implementation	28.81	4.959	74

RQ2. To what extent is there a difference in fifth grade students' value/importance of mathematics, value/importance of science, and value/importance of technology as measured before and after the implementation of Project Lead the Way Launch?

H4. There is a difference in fifth grade students' value/importance of mathematics, as measured before and after the implementation of Project Lead the Way Launch.

A paired-samples *t* test was conducted to test H4. The before implementation survey scores were compared to the after implementation survey scores to assess the change in value/importance of mathematics. The level of significance was set at .05. As shown in Table 9, the results of the paired-samples *t* test indicated no statistically significant difference between the two values, $t = -0.681$, $df = 73$, $p = 0.498$. The sample mean for before PLTW implementation (*M* = 22.53, *SD* = 3.579) was not significantly different from the sample mean for after PLTW implementation (*M* = 22.24, *SD* = 3.078).

The hypothesis was not supported by the data. On average, a student's value/importance of mathematics before and after PLTW implementation was not statistically different.

Table 9

Descriptive Statistics for the Results of the Test for H4

	M	*SD*	*N*
Before implementation	22.53	3.579	74
After implementation	22.24	3.078	74

H5. There is a difference in fifth grade students' value/importance of science, as measured before and after the implementation of Project Lead the Way Launch.

A paired-samples *t* test was conducted to test H5. The before implementation survey scores were compared to the after implementation survey scores to assess the change in value/importance of science. The level of significance was set at .05. As shown in Table 10, the results of the paired-samples *t* test indicated no statistically significant difference between the two values, $t = 0.729$, $df = 69$, $p = 0.468$. The sample mean for before PLTW implementation ($M = 21.04$, $SD = 4.431$) was not significantly different from the sample mean for after PLTW implementation ($M = 21.36$, $SD = 3.923$). The hypothesis was not supported by the data. On average, a student's value/importance of science before and after the PLTW implementation was not significantly different.

Table 10

Descriptive Statistics for the Results of the Test for H5

	M	*SD*	*N*
Before implementation	21.04	4.431	70
After implementation	21.36	3.923	70

H6. There is a difference in fifth grade students' value/importance of technology, as measured before and after the implementation of Project Lead the Way Launch.

A paired-samples *t* test was conducted to test H6. The before implementation survey scores were compared to the after implementation survey scores to assess the change in value/importance of technology. The level of significance was set at .05. As shown in Table 11, the results of the paired-samples *t* test indicated no statistically significant difference between the two values, $t = 0.436$, $df = 73$, $p = 0.664$. The sample mean for before PLTW implementation ($M = 22.15$, $SD = 3.902$) was not significantly different from the sample mean for after PLTW implementation ($M = 22.36$, $SD = 3.887$). The hypothesis was not supported by the data. On average, a student's value/importance of technology before and after PLTW implementation was not significantly different.

Table 11

Descriptive Statistics for the Results of the Test for H6

	M	*SD*	*N*
Before implementation	22.15	3.902	74
After implementation	22.36	3.887	74

RQ3. To what extent is there a difference in fifth grade students' interest in mathematics, interest in science, and interest in technology as measured before and after the implementation of Project Lead the Way Launch?

H7. There is a difference in fifth grade students' interest in mathematics, as measured before and after implementation of Project Lead the Way Launch.

A paired-samples *t* test was conducted to test H7. The before implementation survey scores were compared to the after implementation survey scores to assess the change in interest in mathematics. The level of significance was set at .05. As shown in Table 12, the results of the paired-samples *t* test indicated no statistically significant difference between the two values, $t = 0.258$, $df = 75$, $p = 0.797$. The sample mean for before PLTW implementation ($M = 19.20$, $SD = 6.007$) was not significantly different from the sample mean for after PLTW implementation ($M = 19.36$, $SD = 5.027$). The hypothesis was not supported by the data. On average, a student's interest in mathematics before and after PLTW implementation was not significantly different.

Table 12

Descriptive Statistics for the Results of the Test for H7

	M	*SD*	*N*
Before implementation	19.20	6.007	76
After implementation	19.36	5.027	76

H8. There is a difference in fifth grade students' interest in science, as measured before and after implementation of Project Lead the Way Launch.

A paired-samples *t* test was conducted to test H8. The before implementation survey scores were compared to the after implementation survey scores to assess the change in interest in science. The level of significance was set at .05. As shown in Table 13, the results of the paired-samples *t* test indicated no statistically significant difference between the two values, $t = 1.400$, $df = 69$, $p = 0.166$. The sample mean for before PLTW implementation ($M = 20.17$, $SD = 5.359$) was not significantly different from the sample mean for after PLTW implementation ($M = 21.03$, $SD = 5.368$). The hypothesis was not supported by the data. On average, a student's interest in science before and after PLTW implementation was not significantly different.

Table 13

Descriptive Statistics for the Results of the Test for H8

	M	*SD*	*N*
Before implementation	20.17	5.359	70
After implementation	21.03	5.368	70

H9. There is a difference in fifth grade students' interest in technology, as measured before and after implementation of Project Lead the Way Launch.

A paired-samples *t* test was conducted to test H9. The before implementation survey scores were compared to the after implementation survey scores to assess the change in interest in technology. The level of significance was set at .05. As shown in Table 14, the results of the paired-samples *t* test indicated no statistically significant difference between the two values, $t = 0.200$, $df = 74$, $p = 0.842$. The sample mean for before PLTW implementation ($M = 22.09$, $SD = 4.485$) was not significantly different from the sample mean for after PLTW implementation ($M = 22.20$, $SD = 3.770$). The hypothesis was not supported by the data. On average, a student's interest in technology before and after PLTW implementation was not significantly different.

Table 14

Descriptive Statistics for the Results of the Test for H9

	M	*SD*	*N*
Before implementation	22.09	4.485	75
After implementation	22.20	3.770	75

RQ4. To what extent is the change in fifth grade students' self-concept of mathematics, self-concept of science, and self-concept of technology, as measured before and after the implementation of Project Lead the Way Launch, affected by gender?

H10. The change in fifth grade students' self-concept of mathematics, as measured before and after the implementation of Project Lead the Way Launch, is affected by gender.

A two-sample *t* test was conducted to test H10. The two sample means were compared. The level of significance was set at .05. As shown in Table 15, the results of the two-sample *t* test indicated no statistically significant difference between the two values, $t = -0.257$, $df = 69$, $p = 0.798$. The sample mean change for males ($M = -0.543$, $SD = 5.135$) was not significantly different from the sample mean change for females ($M = -0.833$, $SD = 4.365$). The hypothesis was not supported by the data. On average, the mean change in student's self-concept of mathematics before and after PLTW implementation was not significantly affected by student gender.

Table 15

Descriptive Statistics for the Results of the Test for H10

	M	*SD*	*N*
Males	-0.543	5.135	36
Females	-0.833	4.365	35

H11. The change in fifth grade students' self-concept of science, as measured before and after the implementation of Project Lead the Way Launch, is affected by gender.

A two-sample *t* test was conducted to test H11. The two sample means were compared. The level of significance was set at .05. As shown in Table 16, the results of the two-sample *t* test indicated a statistically significant difference between the two values, $t = -2.134$, $df = 69$, $p = 0.036$. The sample mean change for males ($M = 2.611$, $SD = 4.716$) was significantly different from the sample mean change for females ($M = 0.400$, $SD = 3.972$). The hypothesis was supported by the data. On average, the mean change in student's self-concept of science before and after PLTW implementation was significantly affected by student gender. The mean change for males was significantly higher than was the mean change for females.

Table 16

Descriptive Statistics for the Results of the Test for H11

	M	*SD*	*N*
Males	2.611	4.716	36
Females	0.400	3.972	35

H12. The change in fifth grade students' self-concept of technology, as measured before and after the implementation of Project Lead the Way Launch, is affected by gender.

A two-sample *t* test was conducted to test H12. The two sample means were compared. The level of significance was set at .05. As shown in Table 17, the results of the two-sample *t* test indicated no statistically significant difference between the two values, $t = 1.099$, $df = 72$, $p = 0.276$. The sample mean change for males ($M = -0.921$, $SD = 4.896$) was not significantly different from the sample mean change for females ($M = 0.556$, $SD = 6.583$). The hypothesis was not supported by the data. On average, the mean change in student's self-concept of technology before and after PLTW implementation was not significantly affected by student gender.

Table 17

Descriptive Statistics for the Results of the Test for H11

	M	*SD*	*N*
Males	-0.921	4.896	38
Females	0.556	6.583	36

RQ5. To what extent is the change in fifth grade students' self-concept of mathematics, self-concept of science, and self-concept of technology, as measured before and after implementation of Project Lead the Way Launch, affected by the selected STEM units taught (PLTW recommended vs. teacher recommended)?

H13. The change in fifth grade students' self-concept of mathematics, as measured before and after the implementation of Project Lead the Way Launch, is affected by the selected STEM units taught (PLTW recommended vs. teacher recommended).

A two-sample *t* test was conducted to test H13. The two sample means were compared. The level of significance was set at .05. As shown in Table 18, the results of the two-sample *t* test indicated a statistically significant difference between the two values, $t = -2.268$, $df = 70$, $p = 0.026$. The sample mean change for Center Elementary ($M = -1.971$, $SD = 5.167$) was significantly different from the sample mean change for Red Bridge Elementary ($M = 0.474$, $SD = 3.951$). The hypothesis was supported by the data. On average, the mean change in student's self-concept of mathematics before and after PLTW implementation was significantly affected by the selected STEM units taught. The mean change for student's self-concept of mathematics was significantly higher for the students who were taught the PLTW recommended STEM units than the mean change for students taught the teacher recommended units.

Table 18

Descriptive Statistics for the Results of the Test for H13

	M	*SD*	*N*
Center Elementary	-1.971	5.167	34
Red Bridge Elementary	0.474	3.951	38

H14. The change in fifth grade students' self-concept of science, as measured before and after the implementation of Project Lead the Way Launch, is affected by the selected STEM units taught (PLTW recommended vs. teacher recommended).

A two-sample *t* test was conducted to test H14. The two sample means were compared. The level of significance was set at .05. As shown in Table 19, the results of the two-sample *t* test indicated no statistically significant difference between the two values, $t = -0.460$, $df = 69$, $p = 0.647$. The sample mean change for Center Elementary ($M = 1.250$, $SD = 4.048$) was not significantly different from the sample mean change for Red Bridge Elementary ($M = 1.744$, $SD = 4.838$). The hypothesis was not supported by the data. On average, the mean change in student's self-concept of science before and after PLTW implementation was not significantly affected by the selected STEM units taught.

Table 19

Descriptive Statistics for the Results of the Test for H14

	M	*SD*	*N*
Center Elementary	1.250	4.048	32
Red Bridge Elementary	1.744	4.838	39

H15. The change in fifth grade students' self-concept of technology, as measured before and after the implementation of Project Lead the Way Launch, is affected by the selected STEM units taught (PLTW recommended vs. teacher recommended).

A two-sample *t* test was conducted to test H15. The two sample means were compared. The level of significance was set at .05. As shown in Table 20, the results of the two-sample *t* test indicated no statistically significant difference between the two values, t = -0.232, df = 71, p = 0.817. The sample mean change for Center Elementary (M = -0.371, SD = 6.288) was not significantly different from the sample mean change for Red Bridge Elementary (M = -0.053, SD = 5.447). The hypothesis was not supported by the data. On average, the mean change in student's self-concept of technology before and after PLTW implementation was not significantly affected by the selected STEM units taught.

Table 20

Descriptive Statistics for the Results of the Test for H15

	M	*SD*	*N*
Center Elementary	-0.371	6.288	35
Red Bridge Elementary	-0.053	5.447	38

RQ6. To what extent is the change in fifth grade students' value/importance of mathematics, value/importance of science, and value/importance of technology, as measured before and after the implementation of Project Lead the Way Launch, affected by gender?

H16. The change in fifth grade students' value/importance of mathematics, as measured before and after the implementation of Project Lead the Way Launch, is affected by gender.

A two-sample *t* test was conducted to test H16. The two sample means were compared. The level of significance was set at .05. As shown in Table 21, the results of the two-sample *t* test indicated no statistically significant difference between the two values, $t = 1.336$, $df = 72$, $p = 0.186$. The sample mean change for males ($M = -0.838$, $SD = 3.701$) was not significantly different from the sample mean change for females ($M = 0.270$, $SD = 3.429$). The hypothesis was not supported by the data. On average, the mean change in student's value/importance of mathematics before and after PLTW implementation was not significantly affected by student gender.

Table 21

Descriptive Statistics for the Results of the Test for H16

	M	*SD*	*N*
Males	-0.838	3.701	37
Females	0.270	3.429	37

H17. The change in fifth grade students' value/importance of science, as measured before and after the implementation of Project Lead the Way Launch, is affected by gender.

A two-sample *t* test was conducted to test H17. The two sample means were compared. The level of significance was set at .05. As shown in Table 22, the results of the two-sample *t* test indicated no statistically significant difference between the two values, $t = -0.467$, $df = 68$, $p = 0.642$. The sample mean change for males ($M = 0.500$, $SD = 3.819$) was not significantly different from the sample mean change for females ($M = 0.094$, $SD = 3.383$). The hypothesis was not supported by the data. On average, the mean change in student's value/importance of science before and after PLTW implementation was not significantly affected by student gender.

Table 22

Descriptive Statistics for the Results of the Test for H17

	M	*SD*	*N*
Males	0.500	3.819	38
Females	0.094	3.383	32

H18. The change in fifth grade students' value/importance of technology, as measured before and after the implementation of Project Lead the Way Launch, is affected by gender.

A two-sample *t* test was conducted to test H18. The two sample means were compared. The level of significance was set at .05. As shown in Table 23, the results of the two-sample *t* test indicated no statistically significant difference between the two values, $t = 0.706$, $df = 72$, $p = 0.482$. The sample mean change for males ($M = -0.135$, $SD = 4.008$) was not significantly different from the sample mean change for females ($M = 0.568$, $SD = 4.537$). The hypothesis was not supported by the data. On average, the mean change in student's value/importance of technology before and after PLTW implementation was not significantly affected by student gender.

Table 23

Descriptive Statistics for the Results of the Test for H18

	M	*SD*	*N*
Males	-0.135	4.008	37
Females	0.568	4.537	37

RQ7. To what extent is the change in fifth grade students' value/importance of mathematics, value/importance of science, and value/importance of technology, as measured before and after the implementation of Project Lead the Way Launch, affected by the selected STEM units taught (PLTW recommended vs. teacher recommended)?

H19. The change in fifth grade students' value/importance of mathematics, as measured before and after the implementation of Project Lead the Way Launch, is affected by the selected STEM units taught (PLTW recommended vs. teacher recommended).

A two-sample *t* test was conducted to test H19. The two sample means were compared. The level of significance was set at .05. As shown in Table 24, the results of the two-sample *t* test indicated no statistically significant difference between the two values, $t = 0.772$, $df = 72$, $p = 0.442$. The sample mean change for Center Elementary ($M = 0.057$, $SD = 3.718$) was not significantly different from the sample mean change for Red Bridge Elementary ($M = -0.590$, $SD = 3.485$). The hypothesis was not supported by the data. On average, the mean change in student's value/importance of mathematics before and after PLTW implementation was not significantly affected by the selected STEM units taught.

Table 24

Descriptive Statistics for the Results of the Test for H19

	M	*SD*	*N*
Center Elementary	0.057	3.718	35
Red Bridge Elementary	-0.590	3.485	39

H20. The change in fifth grade students' value/importance of science, as measured before and after the implementation of Project Lead the Way Launch, is affected by the selected STEM units taught (PLTW recommended vs. teacher recommended).

A two-sample *t* test was conducted to test H20. The two sample means were compared. The level of significance was set at .05. As shown in Table 25, the results of the two-sample *t* test indicated no statistically significant difference between the two values, t = -1.282, df = 67, p = 0.204. The sample mean change for Center Elementary (M = -0.281, SD = 3.019) was not significantly different from the sample mean change for Red Bridge Elementary (M = 0.838, SD = 4.059). The hypothesis was not supported by the data. On average, the mean change in student's value/importance of science before and after PLTW implementation was not significantly affected by the selected STEM units taught.

Table 25

Descriptive Statistics for the Results of the Test for H20

	M	*SD*	*N*
Center Elementary	-0.281	3.019	32
Red Bridge Elementary	0.838	4.059	37

H21. The change in fifth grade students' value/importance of technology, as measured before and after the implementation of Project Lead the Way Launch, is affected by the selected STEM units taught (PLTW recommended vs. teacher recommended).

A two-sample *t* test was conducted to test H21. The two sample means were compared. The level of significance was set at .05. As shown in Table 26, the results of the two-sample *t* test indicated no statistically significant difference between the two values, $t = 0.458$, $df = 72$, $p = 0.649$. The sample mean change for Center Elementary ($M = 0.457$, $SD = 3.248$) was not significantly different from the sample mean change for Red Bridge Elementary ($M = 0.000$, $SD = 5.042$). The hypothesis was not supported by the data. On average, the mean change in student's value/importance of technology before and after PLTW implementation was not significantly affected by the selected STEM units taught.

Table 26

Descriptive Statistics for the Results of the Test for H21

	M	*SD*	*N*
Center Elementary	0.457	3.248	35
Red Bridge Elementary	0.000	5.042	39

RQ8. To what extent is the change in fifth grade students' interest in mathematics, interest in science, and interest in technology, as measured before and after the implementation of Project Lead the Way Launch, affected by gender?

H22. The change in fifth grade students' interest in mathematics, as measured before and after the implementation of Project Lead the Way Launch, is affected by gender.

A two-sample *t* test was conducted to test H22. The two sample means were compared. The level of significance was set at .05. As shown in Table 27, the results of the two-sample *t* test indicated no statistically significant difference between the two values, $t = -0.773$, $df = 74$, $p = 0.442$. The sample mean change for males ($M = 0.632$, $SD = 5.053$) was not significantly different from the sample mean change for females ($M = -0.316$, $SD = 5.614$). The hypothesis was not supported by the data. On average, the mean change in student's interest in mathematics before and after PLTW implementation was not significantly affected by student gender.

Table 27

Descriptive Statistics for the Results of the Test for H22

	M	*SD*	*N*
Males	0.632	5.053	38
Females	-0.316	5.614	38

H23. The change in fifth grade students' interest in science, as measured before and after the implementation of Project Lead the Way Launch, is affected by gender.

A two-sample *t* test was conducted to test H23. The two sample means were compared. The level of significance was set at .05. As shown in Table 28, the results of the two-sample *t* test indicated no statistically significant difference between the two values, $t = -0.966$, $df = 68$, $p = 0.338$. The sample mean change for males ($M = 1.385$, $SD = 5.613$) was not significantly different from the sample mean change for females ($M = 0.194$, $SD = 4.430$). The hypothesis was not supported by the data. On average, the mean change in student's interest in science before and after PLTW implementation was not significantly affected by student gender.

Table 28

Descriptive Statistics for the Results of the Test for H23

	M	*SD*	*N*
Males	1.385	5.613	39
Females	0.194	4.430	31

H24. The change in fifth grade students' interest in technology, as measured before and after the implementation of Project Lead the Way Launch, is affected by gender.

A two-sample *t* test was conducted to test H24. The two sample means were compared. The level of significance was set at .05. As shown in Table 29, the results of the two-sample *t* test indicated no statistically significant difference between the two values, $t = -0.898$, $df = 73$, $p = 0.372$. The sample mean change for males ($M = 0.579$, $SD = 3.984$) was not significantly different from the sample mean change for females ($M = -0.378$, $SD = 5.187$). The hypothesis was not supported by the data. On average, the mean change in student's interest in technology before and after PLTW implementation was not significantly affected by student gender.

Table 29

Descriptive Statistics for the Results of the Test for H24

	M	*SD*	*N*
Males	0.579	3.984	38
Females	-0.378	5.187	38

RQ9. To what extent is the change in fifth grade students' interest in mathematics, interest in science, and interest in technology, as measured before and after the implementation of Project Lead the Way Launch, affected by the selected STEM units taught (PLTW recommended vs. teacher recommended)?

H25. The change in fifth grade students' interest in mathematics, as measured before and after the implementation of Project Lead the Way Launch, is affected by the selected STEM units taught (PLTW recommended vs. teacher recommended).

A two-sample *t* test was conducted to test H25. The two sample means were compared. The level of significance was set at .05. As shown in Table 30, the results of the two-sample *t* test indicated no statistically significant difference between the two values, $t = -0.767$, $df = 74$, $p = 0.446$. The sample mean change for Center Elementary ($M = -0.324$, $SD = 5.902$) was not significantly different from the sample mean change for Red Bridge Elementary ($M = 0.615$, $SD = 4.750$). The hypothesis was not supported by the data. On average, the mean change in student's interest in mathematics before and after PLTW implementation was not significantly affected by the selected STEM units taught.

Table 30

Descriptive Statistics for the Results of the Test for H25

	M	*SD*	*N*
Center Elementary	-0.324	5.902	37
Red Bridge Elementary	0.615	4.750	39

H26. The change in fifth grade students' interest in science, as measured before and after the implementation of Project Lead the Way Launch, is affected by the selected STEM units taught (PLTW recommended vs. teacher recommended).

A two-sample *t* test was conducted to test H25. The two sample means were compared. The level of significance was set at .05. As shown in Table 31, the results of the two-sample *t* test indicated no statistically significant difference between the two values, $t = -1.711$, $df = 68$, $p = 0.092$. The sample mean change for Center Elementary ($M = -0.206$, $SD = 5.279$) was not significantly different from the sample mean change for Red Bridge Elementary ($M = 1.861$, $SD = 4.829$). The hypothesis was not supported by the data. On average, the mean change in student's interest in science before and after PLTW implementation was not significantly affected by the selected STEM units taught.

Table 31

Descriptive Statistics for the Results of the Test for H26

	M	*SD*	*N*
Center Elementary	-0.206	5.279	34
Red Bridge Elementary	1.861	4.829	36

H27. The change in fifth grade students' interest in technology, as measured before and after the implementation of Project Lead the Way Launch, is affected by the selected STEM units taught (PLTW recommended vs. teacher recommended).

A two-sample *t* test was conducted to test H27. The two sample means were compared. The level of significance was set at .05. As shown in Table 32, the results of the two-sample *t* test indicated no statistically significant difference between the two values, $t = 0.909$, $df = 73$, $p = 0.366$. The sample mean change for Center Elementary ($M = 0.611$, $SD = 4.291$) was not significantly different from the sample mean change for Red Bridge Elementary ($M = -0.359$, $SD = 4.896$). The hypothesis was not supported by the data. On average, the mean change in student's interest in technology before and after PLTW implementation was not significantly affected by the selected STEM units taught.

Table 32

Descriptive Statistics for the Results of the Test for H27

	M	*SD*	*N*
Center Elementary	0.611	4.291	36
Red Bridge Elementary	-0.359	4.896	39

The results of the of the paired-samples *t* test and two-sample *t* test primarily indicated no significant difference or change after PLTW Launch implementation. The analysis found only three statistically significant differences after PLTW Launch implementation. First, the results of the analysis found a significant difference in fifth grade students' self-concept of science after PLTW Launch implementation. Second, the analysis found that fifth grade students' change in self-concept of science was significantly affected by gender. Third, the analysis found that the selected STEM units taught (PLTW recommended vs. teacher recommended) had a significant change on fifth grade students' self-concept of mathematics after PLTW Launch implementation. See Table 33 for the summary of results for RQ1-RQ9.

Table 33

Summary Results of t Test Analysis by RQ

RQ	Comparison	Variable	*t*	*df*	*p*
1	Pre-Post	SC of mathematics	1.230	70	0.223
		SC of science	2.864	70	0.006*
		SC of technology	-0.301	73	0.764
2	Pre-Post	VI of mathematics	-0.681	73	0.498
		VI of science	0.729	69	0.468
		VI of technology	0.436	73	0.664
3	Pre-Post	I of mathematics	0.258	75	0.797
		I of science	1.400	69	0.166
		I of technology	0.200	74	0.842
4	Gender	SC of mathematics	-0.257	69	0.798
		SC of science	-2.134	69	0.036*
		SC of technology	1.099	72	0.276
5	Units taught	SC of mathematics	-2.268	70	0.026*
		SC of science	-0.460	69	0.647
		SC of technology	-0.232	71	0.817
6	Gender	VI of mathematics	1.336	72	0.186
		VI of science	-0.467	68	0.642
		VI of technology	0.706	72	0.482
7	Units taught	VI of mathematics	0.772	72	0.442
		VI of science	-1.282	67	0.204
		VI of technology	0.458	72	0.649
8	Gender	I of mathematics	-0.773	74	0.442
		I of science	-0.966	68	0.338
		I of technology	-0.898	73	0.372
9	Units taught	I of mathematics	-0.767	74	0.446
		I of science	-1.711	68	0.092
		I of technology	0.909	73	0.366

Note. SC = self-concept, VI = value/importance, I = interest. * = significant

Summary

Chapter four included the descriptive statistics for the sample. The results of the data analysis for each of the hypotheses were also presented. Chapter five includes a summary of the study, the findings related to the literature, and a conclusion, which contains the implications for action and the recommendations for future research.

Chapter Five

Interpretation and Recommendations

A summary of the current study is provided in this chapter, which includes an overview of the problem statement, the study's purpose, and a review of the methodology. Additionally, presented in chapter five are the major findings of this study, which aimed to determine if fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology were significantly different after PLTW Launch implementation. In addition, included in this chapter are the major findings as it relates to the previously reviewed PLTW literature presented in chapter two. This chapter concludes with implications for action and recommendations for future research.

Study Summary

The following section provides a summary of the current study. The summary contains an overview of the problem concerning the implementation of PLTW Launch and the change in fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology. The next section includes the purpose of the study and the research questions. The summary concludes with a review of the methodology and the study's major findings.

Overview of the problem. The authors of multiple reports from as early as 2000 have agreed upon the fact that American students lack interest in studying and pursuing mathematics and science degrees (BHEF, 2007; Business Roundtable, 2005; Feder, 2012; NCES, 2013). Furthermore, the concerns with interest in these fields appear to be intensified with female students (Executive Office of the President, 2010; Gonzalez & Kuenzi, 2012). In 2008, it was found that "only 18.5% of bachelor's degrees in engineering," a field that requires both mathematics and science, "went to women" (Gonzalez & Kuenzi, 2012, p. 12). Due to the known relationship between self-concept, value/importance, and interest, it is imperative that STEM programs, such as PLTW Launch, be studied to determine if such programs have the ability to change students' self-concept, how valuable and important they believe STEM to be, and their interest levels in STEM subjects (Eccels & Wigfield, 2002; Uguroglu & Walberg, 1979; Wigfield & Eccles, 1983).

Due to the recent creation of PLTW (2013) Launch, limited research exists concerning program effectiveness and the impact PLTW Launch has on student attitudes. Leadership in the Center School District was concerned if PLTW Launch would significantly change students' self-concept, value/importance, and interest in mathematics, science, and technology after PLTW Launch implementation. Furthermore, district leadership was concerned whether the change in self-concept, value/importance, and interest in mathematics, science, and technology were significantly different between genders after the implementation of PLTW Launch. Lastly, district leadership was unsure whether the modules selected for the fifth grade would affect student perceptions of self-concept, value/importance, and interest in the STEM fields.

Purpose statement and research questions. The first purpose of the study was to determine if fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology were different after PLTW Launch implementation. The second purpose was to determine if the change in self-concept, value/importance, and interest in mathematics, science, and technology after PLTW Launch implementation was affected by gender. The third purpose was to determine if the change in self-concept, value/importance, and interest in mathematics, science, and technology after PLTW Launch implementation was affected by the selected STEM units taught (PLTW recommended vs. teacher recommended). Nine research questions were posed to address the purposes of this study.

Review of the methodology. Using an alternative treatment pretest-posttest with nonequivalent groups design, fifth grade students from two elementary schools in the Center School District were administered the MST survey before and after the implementation of PLTW Launch. The MST survey was a modification of a survey from the University of Michigan's Childhood and Beyond project. The MST survey was used to collect data to determine the extent of change in fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology after PLTW Launch implementation. Additionally, the MST survey was used to determine if the change in students' self-concept, value/importance, and interest in mathematics, science, and technology was significantly different between genders and selected STEM units taught after PLTW Launch implementation. MST survey responses were analyzed using paired-samples *t* tests to determine if significant differences in fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology occurred after PTLW Launch implementation (RQ1-RQ3). MST survey responses were analyzed using two-sample *t* tests to determine if the change in fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology was affected by gender (RQ4, RQ6, and RQ8). MST survey responses were analyzed using two-sample *t* tests to determine if the change in fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology was affected by the selected STEM units taught (PLTW recommended vs. teacher recommended) (RQ5, RQ7, and RQ9).

Major findings. Of the 27 hypotheses tested, only three had significant differences. Overall, program impact was very weak for the measured variables. As shown in Table 32, the results of the data analysis revealed no significant differences in fifth grade students' self-concept of mathematics and technology after PLTW Launch implementation as measured with the MST survey. Additionally, the results of the data analysis showed no significant differences in fifth grade students' value/importance or interest in mathematics, science, or technology after PLTW Launch implementation.

Of the nine hypotheses related to gender, eight were found not to have statistically significant differences between genders after implementation of PLTW Launch. When analyzing self-concept and gender, the results of the data analysis revealed that changes in fifth grade students' self-concept of mathematics and technology after PLTW Launch implementation were not affected by gender. Similarly, the results of the data analysis determined that changes in fifth grade students' value/importance and interest in mathematics, science, and technology after the implementation of PLTW Launch were not affected by gender.

Of the nine hypotheses related to the selected STEM units, eight were found not to have statistically significant differences between STEM units after implementation of PTLW Launch. When analyzing self-concept and selected STEM units, the results of the data analysis revealed that changes in fifth grade students' self-concept of science and technology after PLTW Launch implementation were not affected by the selected STEM units taught. Comparably, the results of the data analysis revealed that changes in fifth grade students' value/importance and interest in mathematics, science, and technology after PLTW Launch implementation were not affected by the selected STEM units taught.

However, results of the data analysis revealed three significant findings. First, there was a significant difference in fifth grade students' self-concept of science after PLTW Launch implementation. Second, results of the data analysis determined that changes in fifth grade students' self-concept of science after PLTW Launch implementation was affected by gender. Finally, the results of the data analysis revealed that changes in fifth grade students' self-concept of mathematics after PLTW Launch implementation was affected by the selected STEM units taught.

Findings Related to the Literature

The findings of this study as they relate to the reviewed literature that focuses on student attitudes and PLTW are presented in this section. The focus of this study was very precise as it concentrated on three identified attitudes, self-concept, value/importance, and interest, and three identified subjects, mathematics, science, and technology. Due to the highly focused study and the fact that PLTW Launch was a relatively new program, limited research had been completed concerning student attitudes and PLTW. At the time of this study, no research was found related to student attitudes and PLTW Launch.

The findings of this study indicated that the change in male fifth grade students' self-concept of science was significantly different when compared to female fifth grade students' after the implementation of PLTW Launch. Male students' self-concept of science was significantly more positive after PLTW Launch when compared to fifth grade female students' self-concept of science. The 2015 U.S. News/Raytheon STEM Index reported that "gaps between men and women" in STEM fields remain significant and in some cases increasing (Bolkan, 2015, para. 2). However, the findings of this study indicated that the change in male fifth grade students' self-concept of mathematics and technology, value/importance of mathematics, science, and technology, and interest in mathematics, science, and technology was not significantly different from their fifth grade female counterparts. Due to these mixed findings, this study both supports and contests the 2015 U.S. News/Raytheon STEM Index report which claims that STEM fields are experiencing increased gender gaps (Bolkan, 2015).

The findings of this study indicated that the change in fifth grade students' self-concept of mathematics was significantly affected by the selected STEM units taught. Fifth grade students' self-concept of mathematics who received PLTW recommended units was significantly more positive after PLTW Launch when compared to fifth grade students' who received teacher recommend units. The before mentioned result supports the study by Rehmat (2015) who concluded that student attitudes toward STEM subjects could be significantly increased using PBL instruction. PLTW (2014d) is an "activity-, project-, and problem-based" STEM program that many would consider being PBL instruction. In contrast, fifth grade students' self-concept of science and technology, value/importance of mathematics, science, and technology, and interest in mathematics, science, and technology were not affected by the selected STEM units taught. These specific findings contrast Rehmat's (2015) findings, which concluded that student attitudes toward STEM subjects could be significantly increased using PBL instruction.

However, it should be noted that Rehmat (2015) did not specifically mention PLTW as an example of PBL instruction.

More specific to Rehmat's (2015) study, which was broad in nature, Paslov (2006) found that PLTW curriculum did not significantly influence students' attitudes toward mathematics when compared to non-PLTW curriculum. Findings from this study are mixed, both supporting and contesting Paslov's (2006) findings. Overall, fifth grade students' self-concept, value/importance, and interest in mathematics were not significantly different after PLTW Launch implementation. These findings support Paslov's (2006) findings. However, when looking at STEM units taught, the change in self-concept of mathematics after PLTW Launch implementation was significantly greater for students receiving the PLTW recommended units as opposed to the teacher recommended units. These findings contest Paslov's (2006) findings. Again, a notation should be made which states that Paslov (2006) focused on secondary PLTW curriculum and not PLTW Launch. PLTW Launch curriculum may produce different results than the traditional secondary curriculum.

Conclusions

Conclusions drawn from this study are provided in this section. Implications for action and recommendations for future research are included. The section closes with concluding remarks.

Implications for action. The current study can be used by school leaders who are looking to implement a STEM program to improve students' self-concept, value/importance, and interest in STEM fields. School leaders could use the results of this study as one piece of data in the decision-making process when determining whether to implement PLTW Launch. Overall, the results of the study showed ineffectiveness in changing fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology after PLTW Launch implementation. While self-concept of science before PLTW Launch implementation was significantly less than the after implementation self-concept of science, self-concept of mathematics and technology, value/importance of mathematics, science, and technology, and interest in mathematics, science, and technology were not significantly different after PLTW Launch implementation. Due to the weak results of this study, school leaders should not rely solely on this study to determine if PLTW Launch is their program of choice to increase student attitudes in STEM subjects.

School leaders should use caution when considering PLTW Launch as the program of choice to increase female student attitudes in STEM subjects in hopes of closing the attitude gap between genders. The results of this study primarily indicated that the change in student attitudes (self-concept, value/importance, interest) in mathematics, science, and technology were not dependent on gender. Only one attitude, self-concept of science, was affected by gender after PLTW Launch implementation. Male self-concept of mathematics significantly changed after PLTW Launch implementation compared to female self-concept of mathematics.

PLTW (2014j) Launch modules were designed to align with grade specific NGSS standards. However, PLTW (2014j) also states that Launch modules were designed in such a way that modules can be effectively implemented in multiple grades. One of the purposes of this study was to determine if fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology were affected by the selected STEM units taught. After one year of implementation, the results of this study would suggest that the specific STEM units taught did not significantly affect student attitudes. Only one attitude, self-concept of mathematics, was significantly affected by the selected STEM units taught. Therefore, school leaders should feel confident in making curricular changes and aligning PLTW Launch modules to state standards instead of national standards.

Recommendations for future research. This study aided in filling a void in the research related to PLTW Launch, specifically how the program influences student attitudes. The following recommendations are made for those interested in completing similar research as it relates to PLTW Launch and students' self-concept, value/importance, and interest, in mathematics, science, and technology.

1. Future research should include a larger sample and students from multiple elementary grades. When determining the sample, it is recommended that a diverse group of students be selected. The sample should include rural, urban, and suburban students from all socioeconomic and racial backgrounds.
2. Future research should use a mixed methods approach to include interviews with students and teachers allowing the researcher to compare the data analysis with the overall findings from the interviews.
3. Future research should be replicated adding achievement data, such as state testing, as an additional variable allowing the researcher to make more comparisons with the current literature that is primarily related to PLTW and student achievement.

4. This study did not address teachers' attitudes toward PLTW Launch. A qualitative study could be conducted by interviewing teachers to gather their feedback regarding program effectiveness and the level of support received through the provided professional development. The teachers' feedback would provide school leaders with different data to conclude whether the program has met the intended targets.
5. Lastly, future research should include a control group. Researchers should find an equivalent control group within the studied school district or a surrounding district with similar demographics. The control group would allow the researcher to compare students' attitudes after PLTW Launch implementation with students' who did not experience PLTW Launch curriculum. Therefore, more conclusive recommendations regarding program effectiveness and the program's ability to affect students' attitudes could be made.

Concluding remarks. After one year of implementation, this study was conducted to determine if PLTW Launch had positive differences on fifth grade student attitudes, specifically self-concept, value/importance, and interest in mathematics, science, and technology. The results of this study added to the limited research related to student attitudes and PLTW Launch. The results of this study revealed that fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology was largely unchanged after PLTW Launch implementation. Furthermore, the change in fifth grade students' self-concept, value/importance, and interest in mathematics, science, and technology after PLTW Launch implementation was largely unaffected by gender or the selected STEM units taught.

Additional studies need to be conducted because research continues to support the view that U.S. students lack interest and ability in STEM subjects (Bolkan, 2015; Cook et al., 2015). While the results of this study did not reveal the desired outcomes, one year of implementation may not be enough time to reap the benefits of the program. Research indicates that as students mature, self-concept begins to stabilize and becomes even more difficult to change (Eccles et al., 1989). Continued implementation may be necessary before student attitudes significantly change. Lastly, school leaders should not underestimate the need to provide quality professional development when implementing new programs (Gillespie, 2015). Additional time implementing PLTW Launch and additional professional development may be the necessary steps to improving students' self-concept, value/importance, and interest in mathematics, science, and technology.

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Appendices

Appendix A: Detailed Description of PLTW Launch Modules Implemented

PLTW | Launch

2015-16 PLTW Launch Module Descriptions

Modules Aligned to Kindergarten Standards

Structure and Function: Exploring Design
Students discover the design process and how engineers influence their lives. They explore structure and function by identifying products around them designed by engineers, asking questions engineers might ask as they design products, and determining the structure and function of items. Working in small groups, students design, build, and test a structure from available materials to withstand a force. Students apply newly acquired knowledge and skills as they utilize the design process to design, sketch, build, test, and reflect on a new tool design.

Pushes and Pulls
Students investigate different pushes and pulls on the motion of an object and develop knowledge and skills related to forces of differing strengths and directions. Their explorations include pushes and pulls found in their everyday world such as pushing a friend on a swing or pulling a wagon. Students are challenged to refine a design and successfully solve a problem, and they reflect on the effect of modifying the strength or direction of a force.

Structure and Function: Human Body
Students explore the relationship between structure and function in the human body. They examine major structures, or organs, within the body and investigate how the structure of each organ is related to its function. Once students establish an understanding of basic structure and function in the body, they take a deeper look at the functions of bone. Students assemble a skeleton and create a model X-ray of a hand. They act as scientists to perform an inquiry investigation to understand why fingers are made up of more than one bone. Finally, each student works through an engineering design process to design and build a cast to aid healing of a broken bone.

Animals and Algorithms
Students explore the nature of computers and the ways in which humans control and use technology. Starting with a computer-free activity, students learn about the sequential nature of computer programs. Students apply this knowledge to the domain of science when they design a simple algorithm about an animal in its habitat. Using an age-appropriate programming environment, students use their newly developed programming skills to turn their algorithm into a short animation. Through this work, students come to understand that computing is a collaborative activity that can be used to create digital artifacts pertaining to any area of interest.

Modules Aligned to First-Grade Standards

Light and Sound
Students investigate light and sound, including vibration from sound waves and the effect of different materials on the path of a beam of light. After students develop understandings of light and sound, they are challenged to design a model to solve a design problem. Students use the design process to sketch, build, test, and reflect on a device that uses light or sound to communicate over a distance.

Light: Observing the Sun, Moon, and Stars
After observing the sun, moon, and stars, students identify and describe patterns in their recorded data. Students build upon their knowledge of light to design, build, test, and reflect on a device designed to solve a problem related to the patterns of the sun. After evaluating their design, students share their findings and ideas for ways to improve the device based on the testing data.

Animal Adaptations
In this exploration of animal adaptations, students are presented with the problem of preparing an ideal traveler for a visit to an extreme environment and designing the ideal shoe for this traveler to wear in this environment. Students learn what it means for an organism to be adapted to its environment and how different adaptations can be categorized. Through various investigations, students explore adaptations for protection, camouflage, food obtainment, and locomotion. Students combine all of their knowledge of plant and animal adaptations with their understanding of the extreme environment to prepare their travelers and design their shoes.

PLTW | Launch

Animated Storytelling
Through this exploration of both storytelling and animation, students are presented with the problem of arranging moving images and sounds to depict a story. Students learn that computers need specific instructions written in a language that the computer can understand. Students develop an understanding of events as triggers that make computer programs carry out instructions. Combining fundamental ideas in computer science with story-building skills from language arts, students create animations that show characters, settings, actions, and events in a short story of their own creation. The programming environment in which students create these stories is appropriate for emerging readers and offers an appropriately scaffolded environment for piecing together logical steps to produce an animation.

Modules Aligned to Second-Grade Standards

Materials Science: Properties of Matter
In this exploration of materials science, students investigate and classify different kinds of materials by their observable properties, including color, texture, and heat conduction. After analyzing data from materials testing, students apply their knowledge and skills to determine the best material to solve a design problem. Students analyze how well the model solved the problem and determine improvements that could be made to their designs.

Materials Science: Form and Function
Students research the variety of ways animals disperse seeds and pollinate plants. Students expand their understanding of properties of matter as they consider the form and function involved in seed dispersal and pollination. Students gain understanding of form and function and how each concept informs design. The design problem requires students to apply their knowledge and skills to design, build, and test a device that mimics one of the ways animals either disperse seeds or pollinate plants. Students reflect on the efficiency of their designs and how they were informed by nature.

The Changing Earth
Students explore how the surface of the Earth is always changing. They are introduced to different kind of maps and explore how these maps convey different kinds of information about the world in which we live, including where water is found on Earth. Students investigate the different forces that shape the surface of the Earth and design solutions to limit the impact of erosion on a fictional community.

Grids and Games
In this exploration combining mathematics and computers, students investigate numerical relationships while learning about the sequence and structure required in computer programs. Starting with computer-free activities and moving to tablet-based challenges, students apply addition and subtraction strategies to make characters move on a grid. Using skills and knowledge gained from these activities, students work together in groups to design and develop a game in which a player interacts with objects on a tablet screen. Students make extensive use of logic as they create a working game using an event-based model.

Modules Aligned to Third-Grade Standards

Stability and Motion: Science of Flight
Students are engaged in developing an understanding of the forces involved in flight as well as Newton's Laws of Motion. Discovering computer-aided design, students use basic descriptive geometry as a component of design. Students apply their knowledge and skills to design, build, and test an experimental model glider to explore forces that affect flight. In addition, they modify their glider designs as they solve a real-world problem.

Stability and Motion: Forces and Interactions
Students explore simple machines such as wheel and axles, levers, the inclined plane, and more as they investigate the effects of balanced and unbalanced forces on the motion of an object. Additionally, students explore magnetic interactions between two objects not in contact with each other through a hands-on project. Finally, students apply their knowledge of mechanisms and magnetic interactions as part of a solution to a design problem.

PLTW | Launch

Variation of Traits
Students investigate the differences between inherited genetic traits and traits that are learned or influenced by the environment. Students explore the phenomena that offspring may express different traits than parents as they learn about dominant and recessive genes. Students use what they learn to predict inheritance patterns of plants through multiple generations and investigate how predicted outcomes compare to experimental results.

Programming Patterns
Students begin to move beyond basic sequential computer programs to discover the power of modularity and abstraction. Starting with computer-free activities and progressing to programming in a blocks-based language on a tablet, students learn how to think computationally about a problem. They gain appreciation for the powerful computing practice of reducing programmatic solutions so they are generic enough to be reused in a variety of specific circumstances. Building on this transformational way of thinking, students create a final program using modular functions and branching logic.

Modules Aligned to Fourth-Grade Standards

Energy: Collisions
Student exploration of mechanisms includes investigations of how mechanisms change energy by transferring direction, speed, type of movement, and force. Students discover a variety of ways potential energy can be stored and released as kinetic energy. Citing evidence, students explain the relationship between the speed of an object and the energy of that object. They also predict the transfer of energy as a result of a collision between two objects. As students solve the problem for this module, they apply their knowledge and skills related to energy transfer in collisions to develop a vehicle restraint system.

Energy: Conversion
As students learn about forms of energy, they identify the conversion of energy between forms and the energy transfer required to move energy from place to place. Students identify and explain how energy can be converted to meet a human need or want. After exploring energy conversion and transfer, students apply scientific ideas about the conversion of energy to solve a simple design problem. The problem requires students to design a system that is able to store energy and then convert the energy to a usable form as it is released.

Input/Output: Computer Systems
In this exploration of how computers work, students are encouraged to make analogies between the parts of the human body and parts that make up a computer. Students develop a notion of the computer as a machine that takes input, processes information using defined instructions, and produces output. With strong connections to the fourth-grade Human Brain module, students investigate reaction time as a measure of nervous system function. Students apply the knowledge and skills gained throughout the activities to build their own reaction time measurement devices on tablets.

Input/Output: Human Brain
Students discover how signals passing from cell to cell allow us to receive stimuli from the outside world, get this information to the brain for processing, and then send out a signal to generate a response. Students investigate how we take in information through the senses and where the information is processed in the brain. Students work as part of a team to design, plan, and create a video or podcast to raise awareness about concussions and educate children as to how concussions can either be identified early or prevented altogether.

Modules Aligned to Fifth-Grade Standards

Robotics and Automation
Student exploration of robotics includes ways that robots are used in today's world and the impact of their use on society and the environment. Students learn about a variety of robotic components as they build and test mobile robots that may be controlled remotely. The design problem provides an opportunity for students to apply their robotic skills and knowledge to solve a real-world problem related to environmental disaster cleanup.

Robotics and Automation: Challenge

Students expand their understanding of robotics as they explore mechanical design and computer programming. The focus for this module centers on developing skills needed to build and program autonomous robots. Students develop programming skills in a variety of platforms, including tablet applications and browser-based programming environments. Finally, students apply the robotic knowledge and skills they have developed to build and program an autonomous robot to solve a real-world design problem.

Infection: Detection

Students explore transmission of infection, agents of disease, and mechanisms the body uses to stay healthy. Students design and run an experiment related to limiting the spread of germs and apply results to propose appropriate prevention methods. When presented with a fictional disease outbreak scenario, students examine evidence to deduce the agent of infection, the likely source of the outbreak, and the path of transmission through this fictional school.

Infection: Modeling and Simulation

Of all the things computers can do, one of the most helpful is the ability to process a lot of information very quickly. Students discover this and other powerful ideas about computing as they investigate models and simulations. Exploration begins with students acting out a simulation in which they are agents following rules of a given model. Applying their new understandings, they program their own models and collect data by running simulations with different parameters.

PROJECT LEAD THE WAY PLTW

Appendix B: Childhood and Beyond Project Wave 5 Survey

How you feel about yourself

For each question you need to do two things. First, you need to decide which statement is more like you. Choose one side or the other side. Next, indicate with a check mark whether the statement you chose is "sort of true" or "really true" for you. Check only one box for each question.

Try this example:

Really true of me	Sort of true of me				Sort of true of me	Really true of me
		Some kids would rather go to a movie in their spare time	**BUT**	Other kids would rather watch a sports event.		

First decide which is more like you, going to a movie or going to a sports event in your spare time. Once you decide that, then check the box next to the statement you chose to indicate how true it is for you. Is this statement sort of true or really true for you? Check only one box for each question.

Really true of me	Sort of true of me				Sort of true of me	Really true of me
1. _____	_____	Some kids feel that there are a lot of things about themselves that they would change if they could	**BUT**	Other kids would like to stay pretty much the same.	____	_____
2. _____	_____	Some kids are very happy being the way they are	**BUT**	Other kids wish they were different	____	_____
3. _____	_____	Some kids aren't very happy with the way they do a lot of things	**BUT**	Other kids think the way they do things is fine	_____	_____
4. _____	_____	Some kids are pretty sure of themselves	**BUT**	Other kids are not very sure of themselves	_____	_____
5. _____	_____	Some kids feel good about the way they act	**BUT**	Other kids wish they acted differently	_____	_____
6. _____	_____	Some kids are usually sure that what they are doing is the right thing	**BUT**	Other kids aren't so sure whether or not they are doing the right thing	_____	_____
7. _____	_____	Some kids think that maybe they are not a very good person	**BUT**	Other kids are pretty sure they are a good person.	_____	_____

MATH

1. How good at **math** are you?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

2. Some kids find that they are better at one subject or activity than another. Compared to most of your other activities, how good are you at **math**?

1	2	3	4	5	6	7
Not as good as other activities		About the same			A lot better than other activities	

3. If you were to list all the students in your grade from the worst to the best in **math**, where would you put yourself?

1	2	3	4	5	6	7
One of the worst			In the middle			The best

4. How well do you expect to do in **math** next year?

1	2	3	4	5	6	7
Not at all well			O.K.			Very well

5. How good would you be at learning something new in **math**?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

6. In general, how useful is what you learn in **math**?

1	2	3	4	5	6	7
Not at all useful						Very useful

7. Some kids find what they learn in one subject or activity more useful than what they learn in another. Compared to most of your other activities, how useful is what you learn in **math**?

1 2 3 4 5 6 7

Not as useful as what I learn in other activities — About the same — A lot more useful than what I learn in other activities

8. For me, being good at **math** is

1 2 3 4 5 6 7

Not at all important — Very important

9. Some kids believe that it is more important to be better at one subject or activity than another. Compared to most of your other activities, how important is it to you to be good at **math**?

1 2 3 4 5 6 7

Not as important as what I learn in other activities — About the same — A lot more important than what I learn in other activities

10. How much do you like doing **math**?

1 2 3 4 5 6 7

A little — Some — A lot

11. Some kids find that they like one subject or activity much more than another. Compared to most of your other activities, how much do you like **math**?

1 2 3 4 5 6 7

Not as much as other activities — About the same — A lot more than other activities

12. How much do you worry about doing badly in **math**?

1 2 3 4 5 6 7

A little — Some — A lot

13. How good do you think you would be in a career requiring **math** skills?

1 2 3 4 5 6 7

Not at all good — O.K. — Very good

14. In general, I find working on **math** assignments

1 2 3 4 5 6 7

Very — Very

(very fun)

15. How well does your teacher expect you to do in **math** this year?

1	2	3	4	5	6	7
Not at all well						Very well

16. My **math** teacher makes **math** interesting.

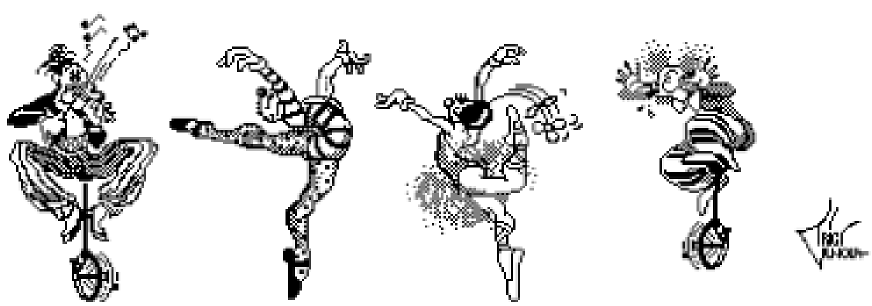
1	2	3	4	5	6	7
Never						All of the time

17. My **math** teacher tells us why it is important to learn **math.**

1	2	3	4	5	6	7
Never						All of the time

18. How often do you wish your were doing something else when you do **math**?

1	2	3	4	5	6	7
Never			Sometimes			Almost every day



ENGLISH

1. How good at **English** are you?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

2. Compared to most of your other activities, how good are you at **English**?

1	2	3	4	5	6	7
Not as good as other activities			About the same			A lot better than other activities

3. If you were to list all the students in your grade from the worst to the best in **English**, where would you put yourself?

1	2	3	4	5	6	7
One of the worst			In the middle			The best

4. How well do you expect to do in **English** next year?

1	2	3	4	5	6	7
Not at all well			O.K.			Very well

5. How good would you be at learning something new in **English**?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

6. In general, how useful is what you learn in **English**?

1	2	3	4	5	6	7
Not at all useful						Very useful

7. Compared to most of your other activities, how useful is what you learn in **English**?

1	2	3	4	5	6	7
Not as useful as what I learn in other activities			About the same			A lot more useful than what I learn in other activities

8. For me, being good at **English** is

1	2	3	4	5	6	7
Not at all important						Very important

9. Compared to most of your other activities, how important is it to you to be good at **English?**

1	2	3	4	5	6	7
Not as important as what I learn in other activities			About the same			A lot more important than what I learn in other activities

10. How much do you like doing **English?**

1	2	3	4	5	6	7
A little			Some			A lot

11. Compared to most of your other activities, how much do you like **English?**

1	2	3	4	5	6	7
Not as much as other activities			About the same			A lot more than other activities

12. How much do you worry about doing badly in **English?**

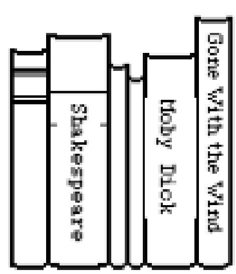
1	2	3	4	5	6	7
A little			Some			A lot

13. How good do you think you would be in a career requiring **English** skills?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

14. In general, I find working on **English** assignments

1	2	3	4	5	6	7
Very boring						Very interesting (very fun)



15. How well does your teacher expect you to do in **English** this year?

1	2	3	4	5	6	7
Not at all well						Very well

16. My **English** teacher makes **English** interesting.

1	2	3	4	5	6	7
Never						All of the time

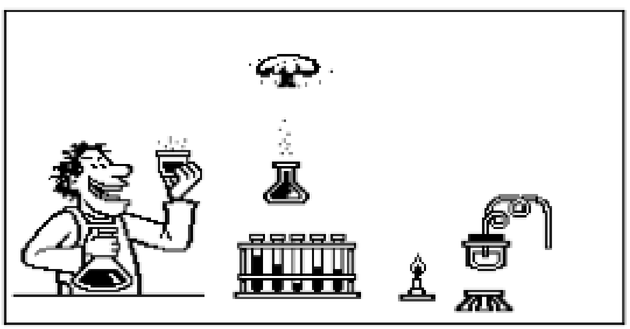
17. My **English** teacher tells us why it is important to learn **English**.

1	2	3	4	5	6	7
Never						All of the time

18. How often do you wish your were doing something else when you do **English**?

1	2	3	4	5	6	7
Never			Sometimes			Almost every day

PHYSICS AND CHEMISTRY



Some students take chemistry and physics in high school. Answer the following questions about these subjects.

1. Are you planning to take chemistry in high school?

2. Are you planning to take physics in high school?

_____ already taken _____ yes _____ no _____ don't know yet

3. Are you planning to take biology in high school?

_____ already taken _____ yes _____ no _____ don't know yet

4. How good do you think you would be at **physics and chemistry** ?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

5. How well do you expect to do in **physics and chemistry** in high school?

1	2	3	4	5	6	7
Not at all well			O.K.			Very well

6. In general, how useful do you think what you learn in **physics and chemistry** will be?

1	2	3	4	5	6	7
Not at all useful						Very useful

7. For me, being good at **physics and chemistry** is

1	2	3	4	5	6	7
Not at all important						Very important

8. How much do you think you will like doing **physics and chemistry**?

1	2	3	4	5	6	7
A little			Some			A lot

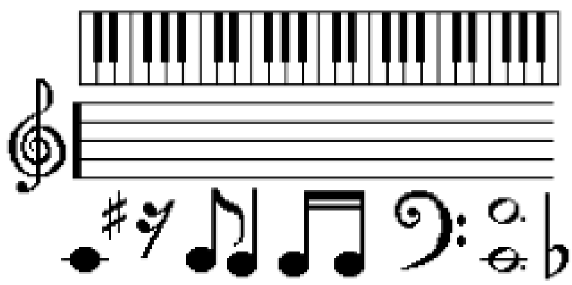
9. How good do you think you would be in a career requiring **physics and chemistry** skills?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

10. In general, I think I will find working on **physics and chemistry** assignments

1	2	3	4	5	6	7
Very boring						Very interesting (very fun)

INSTRUMENTAL MUSIC



1. How good are you at playing a **musical instrument**?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

2. Compared to your other activities, how good are you at **playing a musical instrument**?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

3. If you were to list all the students in your grade from the worst to the best in **playing a musical instrument**, where would you put yourself?

1	2	3	4	5	6	7
One of the worst			In the middle			The best

4. How good would you be at learning to play a new **musical instrument**?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

5. In general, how useful is being able to play a **musical instrument**?

1	2	3	4	5	6	7
Not at all useful						Very useful

6. For me, being good at **playing a musical instrument** is

1	2	3	4	5	6	7
Not at all important						Very important

7. Compared to most of your other activities, how important is it to you to be good at **playing a musical instrument?**

1	2	3	4	5	6	7
Not as important as what I learn in other activities			About the same			A lot more important than what I learn in other activities

8. How much do you like playing a **musical instrument**?

1	2	3	4	5	6	7
A little			Some			A lot

9. Compared to most of your other activities, how much do you like playing a **musical instrument?**

1	2	3	4	5	6	7
Not as much as other activities			About the same			A lot more than other activities

10. How much do you worry about doing badly when you **play a musical instrument?**

1	2	3	4	5	6	7
A little			Some			A lot

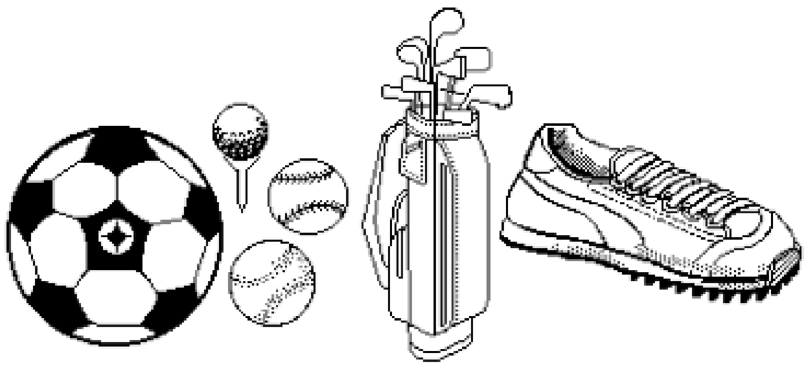
11. How good do you think you would be in a career **playing a musical instrument?**

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

12. In general, I find **playing a musical instrument**

1	2	3	4	5	6	7
Very boring						Very interesting (very fun)

SPORTS



1. How good at **sports** are you?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

2. How good at **throwing and catching a ball** are you?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

3. How good at **gymnastics** are you?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

4. Compared to most of your other activities, how good are you at **sports**?

1	2	3	4	5	6	7
Not as good as other activities			About the same			A lot better than other activities

5. If you were to list all the students in your class from the worst to the best in **sports**, where would you put yourself?

1	2	3	4	5	6	7
One of the worst			In the middle			The best

6. How well do you expect to do in your favorite **sport** next year?

1	2	3	4	5	6	7
Not at all well			O.K.			Very well

7. How good would you be at learning something new in **sports**?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

8. In general, how useful is what you learn in **sports**?

1	2	3	4	5	6	7
Not at all useful						Very useful

9. Compared to most of your other activities, how useful is being good at **sports**?

1	2	3	4	5	6	7
Not as useful as what I learn in other activities		About the same			A lot more useful than what I learn in other activities	

10. For me, being good at **sports** is

1	2	3	4	5	6	7
Not at all important						Very important

11. Compared to most of your other activities, how important is it to you to be good at **sports**?

1	2	3	4	5	6	7
Not as important as what I learn in other activities			About the same			A lot more important than what I learn in other activities

12. How much do you like playing **sports**?

1	2	3	4	5	6	7
A little			Some			A lot

13. Compared to most of your other activities, how much do you like **sports**?

1	2	3	4	5	6	7
Not as much as other activities			About the same			A lot more than other activities

14. How much do you worry about doing badly in **sports**?

1	2	3	4	5	6	7
A little			Some			A lot

15. How good do you think you would be in a career requiring **sports** skills?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

16. In general, I find playing **sports**

1	2	3	4	5	6	7
Very boring						Very interesting (very fun)

Activities:

1. Of the following activities, **Math, English/Reading, Sports, and Playing a musical instrument**:

Which activity do you **like the best?** ______________________

Which activity do you **like the least?** ______________________

Which activity are you **best at?** ___________________________

Which activity are you **least good at?** ______________________

Think about the kinds of things you usually do after school and on weekends. About how many hours each week do you usually spend on these activities (check one line for each activity):

doing homework?

____ none	____ 2-3 hours	____ 11-15 hours
____ 1 hour or less	____ 4-6 hours	____ 16-20 hours
	____ 7-10 hours	____ 21 or more hours

hanging out with friends?

____ none	____ 2-3 hours	____ 11-15 hours
____ 1 hour or less	____ 4-6 hours	____ 16-20 hours
	____ 7-10 hours	____ 21 or more hours

talking to friends on the phone?

____ none	____ 2-3 hours	____ 11-15 hours
____ 1 hour or less	____ 4-6 hours	____ 16-20 hours
	____ 7-10 hours	____ 21 or more hours

reading for fun?

____ none	____ 2-3 hours	____ 11-15 hours
____ 1 hour or less	____ 4-6 hours	____ 16-20 hours
	____ 7-10 hours	____ 21 or more hours

taking part in organized sports?

____ none	____ 2-3 hours	____ 11-15 hours
____ 1 hour or less	____ 4-6 hours	____ 16-20 hours
	____ 7-10 hours	____ 21 or more hours

What sports do you play (Include all sports you play during the year)?

____

doing other athletic or sports activities?

____ none	____ 2-3 hours	____ 11-15 hours
____ 1 hour or less	____ 4-6 hours	____ 16-20 hours
	____ 7-10 hours	____ 21 or more hours

What sports activities are these (List all)?

____

fixing family meals?

____ none	____ 2-3 hours	____ 11-15 hours
____ 1 hour or less	____ 4-6 hours	____ 16-20 hours
	____ 7-10 hours	____ 21 or more hours

doing things with your family?

____ none	____ 2-3 hours	____ 11-15 hours
____ 1 hour or less	____ 4-6 hours	____ 16-20 hours
	____ 7-10 hours	____ 21 or more hours

taking care of younger brothers or sisters?

____ none	____ 2-3 hours	____ 11-15 hours
____ 1 hour or less	____ 4-6 hours	____ 16-20 hours
	____ 7-10 hours	____ 21 or more hours

other indoor housework or chores at home?

____ none	____ 2-3 hours	____ 11-15 hours
____ 1 hour or less	____ 4-6 hours	____ 16-20 hours
	____ 7-10 hours	____ 21 or more hours

yardwork and other outdoor chores at home?

____ none	____ 2-3 hours	____ 11-15 hours
____ 1 hour or less	____ 4-6 hours	____ 16-20 hours
	____ 7-10 hours	____ 21 or more hours

providing volunteer or community service?

____ none	____ 2-3 hours	____ 11-15 hours
____ 1 hour or less	____ 4-6 hours	____ 16-20 hours
	____ 7-10 hours	____ 21 or more hours

What volunteering do you do (Please explain)?

____

working for pay?

____ none	____ 2-3 hours	____ 11-15 hours
____ 1 hour or less	____ 4-6 hours	____ 16-20 hours
	____ 7-10 hours	____ 21 or more hours

What job do you have (Please explain)?

____

going to religious services and doing religious activities?

____ none	____ 2-3 hours	____ 11-15 hours
____ 1 hour or less	____ 4-6 hours	____ 16-20 hours
	____ 7-10 hours	____ 21 or more hours

participating in any school clubs or organizations?

____ none	____ 2-3 hours	____ 11-15 hours
____ 1 hour or less	____ 4-6 hours	____ 16-20 hours
	____ 7-10 hours	____ 21 or more hours

What clubs or organizations do you participate in (Please explain)?

____

watching TV?

____ none	____ 2-3 hours	____ 11-15 hours
____ 1 hour or less	____ 4-6 hours	____ 16-20 hours
	____ 7-10 hours	____ 21 or more hours

2. What is your favorite leisure activity or hobby (please explain if necessary)?

____

3. How many hours each week do you usually spend on this activity?

____ none	____ 2-3 hours	____ 11-15 hours
____ 1 hour or less	____ 4-6 hours	____ 16-20 hours
	____ 7-10 hours	____ 21 or more hours

4. What is it about this activity that you like?

____

5. What is your favorite TV show? ___________________________

<u>Favorite subject</u>

1. What is your <u>favorite school subject</u> (not lunch or study periods)? ____________________

2. How often do you <u>feel excited and challenged</u> (rather than bored) while you are doing this subject?

1	2	3	4	5	6	7
Never			Sometimes			Almost always

3. How often do you <u>feel completely involved</u> in the task while you are doing this subject?

1	2	3	4	5	6	7
Never			Sometimes			Almost always

4. How often do you <u>feel good</u> about yourself while you are doing this subject?

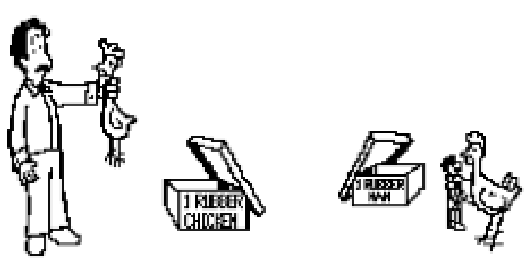
1	2	3	4	5	6	7
Never			Sometimes			Almost always

5. How often do you <u>feel tense and anxious</u> while you are doing this subject?

1	2	3	4	5	6	7
Never			Sometimes			Almost always

6. How often do you <u>wish you were doing something else</u> while you are doing this subject?

1	2	3	4	5	6	7
Never			Sometimes			Almost Always



Competitive sports

1. How often do you feel excited and challenged (rather than bored) while you are playing competitive sports

1 2 3 4 5 6 7
Never Sometimes Almost always

2. How often do you feel completely involved in the task while you are playing competitive sports?

1 2 3 4 5 6 7
Never Sometimes Almost always

3. How often do you feel good about yourself while you are playing competitive sports?

1 2 3 4 5 6 7
Never Sometimes Almost always

4. How often do you feel tense and anxious while you are playing competitive sports?

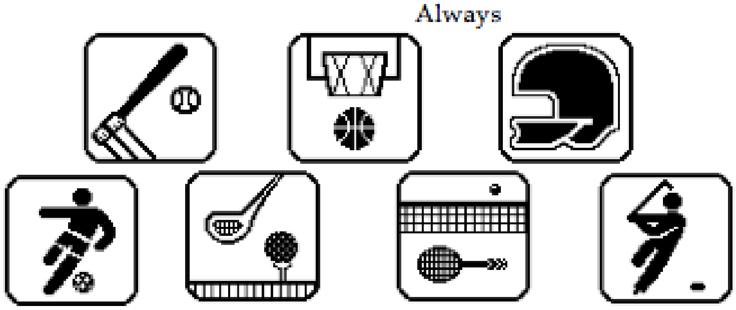
1 2 3 4 5 6 7
Never Sometimes Almost always

5. How often do you feel afraid when you are playing competitive sports?

1 2 3 4 5 6 7
Never Sometimes Almost always

6. How often do you wish you were doing something else when you are playing competitive sports?

1 2 3 4 5 6 7
Never Sometimes Almost Always



Musical instrument

1. Do you play a musical instrument? _____ yes _______no

If you checked no, go to page 20, Other Activities section

If you checked yes, please answer the following questions:

2. How many hours each week do you usually spend playing a musical instrument?

____ 1 hour or less ____ 4-6 hours ____ 11-15 hours
____ 2-3 hours ____ 7-10 hours ____ 16-20 hours
____ 21 or more hours

What musical instrument(s) do you play (List all)?

____

3. How often do you feel excited and challenged (rather than bored) while you are playing your instrument

1	2	3	4	5	6	7
Never			Sometimes			Almost always

4. How often do you feel completely involved in the task while you are playing your instrument?

1	2	3	4	5	6	7
Never			Sometimes			Almost always

5. How often do you feel good about yourself while you are playing your instrument?

1	2	3	4	5	6	7
Never			Sometimes			Almost always

6. How often do you feel tense and anxious while you are playing your instrument?

1	2	3	4	5	6	7
Never			Sometimes			Almost always

7. How often do you wish you were doing something else while you are playing your instrument?

1	2	3	4	5	6	7
Never			Sometimes			Almost always

Now go to page 21, Friends section.

Other Activities

1. Do you do any other activities such as choir or other vocal music, dance, drama, painting, drawing, etc.?

_____ yes _____no

If you checked no, go to page 21, Friends section.

If you checked yes, please answer the following questions:

2. Which other activity do you participate in? ___________________________

3. How many hours each week do you usually spend doing this activity?

____ 1 hour or less	____ 4-6 hours	____ 11-15 hours
____ 2-3 hours	____ 7-10 hours	____ 16-20 hours
		____ 21 or more hours

4. How often do you feel excited and challenged (rather than bored) while you are doing this activity?

1	2	3	4	5	6	7
Never			Sometimes			Almost always

5. How often do you feel completely involved in the task while you are doing this activity?

1	2	3	4	5	6	7
Never			Sometimes			Almost always

6. How often do you feel good about yourself while you are doing this activity?

1	2	3	4	5	6	7
Never			Sometimes			Almost always

7. How often do you feel tense and anxious while you are doing this activity?

1	2	3	4	5	6	7
Never			Sometimes			Almost always

8. How often do you wish you were doing something else while you are doing this activity?

1	2	3	4	5	6	7
Never			Sometimes			Almost always

Friends

Now think about when you are doing things with your friends.

1. How often do you feel challenged intellectually (have stimulating intellectual discussions) while you are hanging out with your friends

1	2	3	4	5	6	7
Never			Sometimes			Almost always

2. How often do you feel good about yourself while you are hanging out with your friends?

1	2	3	4	5	6	7
Never			Sometimes			Almost always

3. How often do you feel tense and anxious while you are hanging out with your friends?

1	2	3	4	5	6	7
Never			Sometimes			Almost always

4. How often do you wish you were doing something else while you are hanging out with your friends?

1	2	3	4	5	6	7
Never			Sometimes			Almost always

6. How often do you feel left out when you are with your friends?

1	2	3	4	5	6	7
Never			Sometimes			Almost always

7. What are your favorite activities you do with your friends?

____

____

____

School Issues

1. Does your **heart beat faster** when you have to **take a test**?

1	2	3	4	5	6	7
Not at all faster						A lot faster

2. While you are **taking a test**, how **nervous** do you get?

1	2	3	4	5	6	7
A little			Some			A lot

3. I worry about what people think when I **make mistakes** in front of the class.

1	2	3	4	5	6	7
Almost never			Some of the time			All the time

4. If your teacher asked you to get up in front of the class and talk, **how nervous** would you be?

1	2	3	4	5	6	7
Not at all nervous						Very nervous

5. On your last semester report card, how many . . .

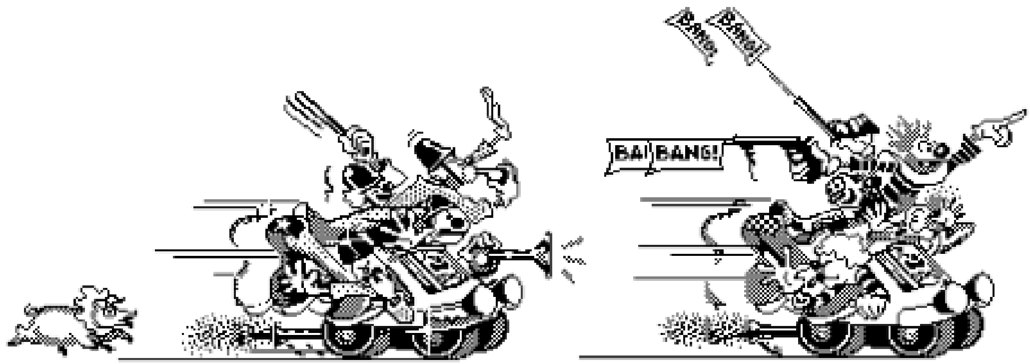
A's did you get? ________ (# of A's on your report card)

B's did you get? ________ (# of B's on your report card)

C's did you get? ________ (# of C's on your report card)

D's did you get? ________ (# of D's on your report card)

E's (or F's) did you get? ________ (# of E's on your report card)



6. How many teachers in your school value and listen to students' ideas?

1	2	3	4	5	6	7
None			Half			All

7. How many teachers at this school treat students with respect?

1	2	3	4	5	6	7
None			Half			All

8. How many of your teachers are willing to help you on homework?

1	2	3	4	5	6	7
None			Half			All

9. How many of your teachers treat you like a grown-up?

1	2	3	4	5	6	7
None			Half			All

10. How many of your teachers have given up on some of their students?

1	2	3	4	5	6	7
None			Half			All

11. How many of your teachers only care about the smart kids?

1	2	3	4	5	6	7
None			Half			All

12. How many of your teachers think every student can be successful?

1	2	3	4	5	6	7
None			Half			All

13. How many of your teachers believe all students can learn?

1 2 3 4 5 6 7
None Half All

14. How many of your teachers think mistakes are okay as long as we are learning?

1 2 3 4 5 6 7
None Half All

15. In this school, teachers and students really trust one another.

1 2 3 4 5 6 7
Almost never Sometimes Almost always

16. How often do you worry about getting picked on by other kids at school?

1 2 3 4 5 6 7
Almost never Sometimes Almost always

17. How often do you worry about having someone break into your locker at school?

1 2 3 4 5 6 7
Almost never Sometimes Almost always

18. How often do you worry about violence in your school?

1 2 3 4 5 6 7
Almost never Sometimes Almost always

19. When you are in school, how often do you feel:

» **left out of things**

1 2 3 4 5 6 7
Never Sometimes All of the time

» **lonely**

1 2 3 4 5 6 7
Never Sometimes All of the time

» that I really belong in this school

1 2 3 4 5 6 7
Never Sometimes All of the time

» like you matter at this school

1 2 3 4 5 6 7
Never Sometimes All of the time

» challenged by your classes

1 2 3 4 5 6 7
Never Sometimes All of the time

» like you are learning a lot in your classes

1 2 3 4 5 6 7
Never Sometimes All of the time

» good about yourself

1 2 3 4 5 6 7
Never Sometimes All of the time

FUTURE EXPECTATIONS

1. How old do you think you will be when you get married? ____________
Check here if you do not think you will ever get married: _____

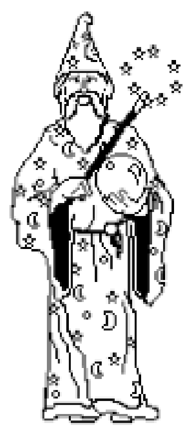
2. How old do you think you will be when you have your first child? ___________
How many children would you like to have? __________
Check here if you do not think you will ever have children: ______

3. How likely is it that you will have difficulty supporting your family financially?

1	2	3	4	5	6	7
Very unlikely						Very likely

4. If you could do exactly what you wanted, how far would you like to go in school (check the highest level of education you would like to get)?

___ 8th grade or less
___ 9th-11th grade
___ graduate from high school
___ post high school vocational or technical training
___ some college
___ graduate from a business college or a two year college with an associates degree
___ graduate from a 4 year college
  If you check this, what would you like to major in? __________________
___ get a masters degree or a teaching credential
  If you check this, what would you like your degree to be in? ____________
___ get a law degree, a Ph.D., or a medical doctor's degree
  If you check this, what would you like your field of study to be? __________



We can't always do what we most want to do. How likely do you think each of the following will be:

you will drop out of high school before you finish

1	2	3	4	5	6	7
Very unlikely						Very likely

you will go to work full time right after high school

1	2	3	4	5	6	7
Very unlikely						Very likely

you will go into the military right after high school

1	2	3	4	5	6	7
Very unlikely						Very likely

you will graduate from college (four year program)

1	2	3	4	5	6	7
Very unlikely						Very likely

you will attend graduate or professional school after college

1	2	3	4	5	6	7
Very unlikely						Very likely

8. What job would you most like to have when you are done with your schooling (write the job and please be specific about what you would be doing)?

____

____

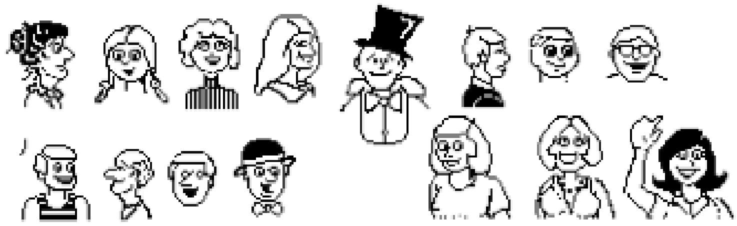
9. How likely is it that you will be able to get this type of job?

1	2	3	4	5	6	7
Very unlikely						Very likely

10. List two other jobs you have considered doing:

1. ______________________________

2. ___________________________



Many people have in mind the kind of person they want to be like in the future regardless of how likely it is they will actually be that way. These are the kinds of selves that you most want to be like. Think about four possible selves that you **most hope to be** by the time you are 25 years old. Please list them below:

1. ________________________ 2. ________________________

3. ________________________ 4. ________________________

Now think of the four possible selves that you fear or worry about becoming by the time you are 25. These are the selves that you **most want not to be** or that you most want to avoid being when you are 25. Please list them below.

1. ________________________ 2. ________________________

3. ________________________ 4. ________________________

Friends and Dating

1. How popular are you with **boys**?

1	2	3	4	5	6	7
Not at all popular						Very popular

2. How popular are you with **girls**?

1	2	3	4	5	6	7
Not at all popular						Very popular

3. How good looking are you?

1	2	3	4	5	6	7
Not at all good looking						Very good looking

4. If you were to list all the students in your class from the worst to the best **looking**, where would you put yourself?

1	2	3	4	5	6	7
One of the worst looking			In the middle			The best looking

5. How good are you at **making new friends**?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

6. If you were to list all the students in your class from the worst to the best at **making new friends**, where would you put yourself?

1	2	3	4	5	6	7
One of the worst at making new friends			In the middle			The best at making new friends

7. How worried are you that **boys** don't like you?

1	2	3	4	5	6	7
A little			Some			A lot

8. How worried are you that **girls** don't like you?

1	2	3	4	5	6	7
A little			Some			A lot

9. How worried are you that you are not **good looking** enough?

1	2	3	4	5	6	7

A little Some A lot

10. When I do something stupid at a party or with friends, I worry about what other kids think.

1	2	3	4	5	6	7
Almost never			Some of the time			All the time

11. How many best friends do you have?

____

12. I would act dumber or less talented than I really am in order to be popular with my friends.

1	2	3	4	5	6	7
Not at all true						Very true

13. It's OK to let your schoolwork slip or get a lower grade in order to be popular with your friends.

1	2	3	4	5	6	7
Not at all true						Very true

14. To be popular with my friends, I sometimes don't try as hard as I could in school.

1	2	3	4	5	6	7
Not at all true						Very true

15. It's ok to break some of your parents' rules in order to keep your friends.

1	2	3	4	5	6	7
Not at all true						Very true

All kids are different. Think about how many of your friends do the following things:

16. How many of your friends encourage you to disobey your parents.

1	2	3	4	5	6	7
None			Half			All

17. How many of your friends encourage you to do your best in school.

1	2	3	4	5	6	7
None			Half			All

18. How many of your friends encourage you to do dangerous things.

1	2	3	4	5	6	7

None Half All

19. How many of your friends would tease you if you spent a lot of time on homework.

1 2 3 4 5 6 7
None Half All

20. How many of your friends get in trouble in school?

1 2 3 4 5 6 7
None Half All

21. How many of your friends regularly attend religious services?

1 2 3 4 5 6 7
None Half All

22. How many of your friends get in a lot of fights with other kids?

1 2 3 4 5 6 7
None Half All

23. How many of your friends are involved with sports?

1 2 3 4 5 6 7
None Half All

24. How many of your friends work out or exercise regularly?

1 2 3 4 5 6 7
None Half All

25. How many of your friends think school work is very important?

1 2 3 4 5 6 7
None Half All

26. How many of your friends are likely to skip school a lot?

1 2 3 4 5 6 7
None Half All

27. How many of your friends are involved with student government or other school activities?

1 2 3 4 5 6 7
None Half All

28. How many of your friends get drunk at least once a week?

1 2 3 4 5 6 7

None Half All

29. How many of your friends <u>think it's important to do volunteer work or help out in their communities?</u>

1	2	3	4	5	6	7
None			Half			All

30. How many of your friends <u>have been suspended from school?</u>

1	2	3	4	5	6	7
None			Half			All

31. Are you allowed to date? ____ yes ____ no

32. Do you go out on dates? ____ yes ____ no

If no, go to question 33.

If yes, how often do you go out on dates?

1	2	3	4	5	6	7
Never			Sometimes			Very often (at least twice a week)

If yes, when you are out on a date, do your parents set a time you have to be home?

1	2	3	4	5	6	7
Never			Sometimes			Always

What time do you have to be home when you are out on a date?

____

33. If you had 3 wishes, what would you wish for?

a) ____

b) ____

c) ____

FAMILY

1. We are interested in who lives in your house:

How many older brothers live with you? ______ How many younger brothers live with you? ______

How many older sisters live with you? ______ How many younger sisters live with you? ______

2. Are your mother and father (check one):

_____ married to each other

_____ divorced from each other

_____ separated from each other

_____ widowed (one of your parents is dead)

Please note: If your parents do not live together, answer the following questions for the family you spend the most time with.

How often does your mom or dad do the following things with you?
(Check only one box per line)

Never *means* **Never or almost never**
A little *means* **Once or twice a month or less**
Sometimes *means* **About once a week**
Often *means* **A couple times a week**
Very often *means* **Almost every day for a little while**
A lot *means* **Almost every day for lots of time each day**

ACTIVITY	Never	A little	Some-times	Often	Very Often	A lot
1. Help you with your math or science homework						
2. Help you with your English homework						
3. Help you with other school work or school projects						
4. Play a sport or coach you on a sports skill						
5. Play a musical instrument with you or help you play a musical instrument						
6. Talk with you to help you solve problems with your friends						
7. Talk to you about things you're interested in						
8. Take you to a sporting event						
9. Take you to a musical concert						
10. Take you to a museum or library						

16. How often do your parents know where your are?

1 2 3 4 5 6 7

Almost never	Some of the time	All of the time

17. How often do your parents know who you are with?

1	2	3	4	5	6	7
Almost never			Some of the time			All of the time

18. How often have you and your parents talked about the following topics:
(Check only one box per line)

	No, never	Yes, once or twice	Yes, several times
issues around sexuality			
career plans			
use of drugs and/or alcohol			
what courses to take in high school			
romantic relationships			
religion/spirituality			
citizenship/participating in your community			
becoming an adult/taking on more responsibilities			

19. Who decides what time you have to be home at night? (Check one)

____ 1. My parents just tell me what to do.
____ 2. My parents ask me how I feel and then they decide.
____ 3. My parents and I make the decisions together.
____ 4. My parents tell me how they feel and then I decide.
____ 5. My parents let me decide.

20. Who decides which classes you take in school? (Check one)

____ 1. My parents just tell me what to do.
____ 2. My parents ask me how I feel and then they decide.
____ 3. My parents and I make the decisions together.
____ 4. My parents tell me how they feel and then I decide.
____ 5. My parents let me decide.

21. Who decides whether you can go out on date? (Check one)

____ 1. My parents just tell me what to do.
____ 2. My parents ask me how I feel and then they decide.
____ 3. My parents and I make the decisions together.
____ 4. My parents tell me how they feel and then I decide.
____ 5. My parents let me decide.

22. Who decides who you can go out on dates with? (Check one)

____ 1. My parents just tell me what to do.
____ 2. My parents ask me how I feel and then they decide.
____ 3. My parents and I make the decisions together.
____ 4. My parents tell me how they feel and then I decide.
____ 5. My parents let me decide.

23. In general, how are most important decisions that affect you made in your family?

____ 1. My parents just tell me what to do.
____ 2. My parents ask me how I feel and then they decide.
____ 3. My parents and I make the decisions together.
____ 4. My parents tell me how they feel and then I decide.
____ 5. My parents let me decide.

24. In general, who should make most important decisions that affect you?

____ 1. My parents should just tell me what to do.
____ 2. My parents should ask me how I feel and then they should decide.
____ 3. My parents and I should make the decisions together.
____ 4. My parents should tell me how they feel and then I should decide.
____ 5. My parents should let me decide.

25. The rules in my family **are quite clear.**

1	2	3	4	5	6	7
Almost never			Some of the time			All of the time

26. My parent(s) know **if I follow family rules.**

1	2	3	4	5	6	7
Almost never			Some of the time			All of the time

27. How often **do** you get to take part in making family decisions that concern you?

1	2	3	4	5	6	7
Almost never			Some of the time			All of the time

28. How often **should** you get to take part in making family decisions that concern you?

1	2	3	4	5	6	7
Almost never			Some of the time			All of the time

29. My parents enforce their rules even if I try to talk them out of it.

1	2	3	4	5	6	7
Almost never			Some of the time			All of the time

30. My parents are. . .

1	2	3	4	5	6	7
Not at all strict						Very strict

31. How many of your friends do your parents approve of?

1	2	3	4	5	6	7
None			Half			All

33. Now, thinking about your parent(s), how often do you think:
your parent(s) is always telling you what to do and how to act

1	2	3	4	5	6	7
Almost never			Some of the time			All of the time

your parent(s) asks you too many questions about where you've been going or what you've been doing

1	2	3	4	5	6	7
Almost never			Some of the time			All of the time

your parent(s) has too many rules for you

1	2	3	4	5	6	7
Almost never			Some of the time			All of the time

your parent(s) treats you more like a kid than like an adult

1	2	3	4	5	6	7
Almost never			Some of the time			All of the time

Now, please answer the following questions about you and your family.
34. I feel like I don't belong in my family.

1	2	3	4	5	6	7
Almost never			Some of the time			All of the time

35. I feel lonely when I'm with my family.

1	2	3	4	5	6	7
Almost never			Some of the time			All of the time

36. I feel like an outsider with my family.

1	2	3	4	5	6	7
Almost never			Some of the time			All of the time

37. Our home is a neat and orderly place.

1	2	3	4	5	6	7
Not at						Very

all true true

38. Family members help and support each other.

1	2	3	4	5	6	7
Not at all true						Very true

39. Household responsibilities and family schedules are well organized.

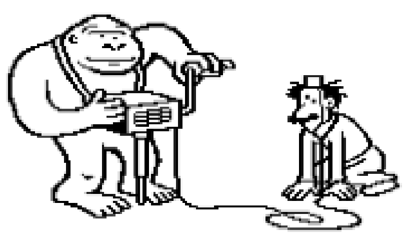
1	2	3	4	5	6	7
Not at all true						Very true

40. Family members criticize each other a lot.

1	2	3	4	5	6	7
Not at all true						Very true

41. Our family enjoys talking and doing things together.

1	2	3	4	5	6	7
Not at all true						Very true



Now answer the following questions about your biological or adoptive mother (not your stepmother). If you do not have a mother or feel like you can't answer these questions, skip to question # 38, page 41.

34. How much do you want to be like the kind of person your **mother** is when you are an adult?

1	2	3	4
Not at all	Just a little	Quite a bit	A lot

35. How much do you respect your **mother**?

1	2	3	4
Not at all	Just a little	Quite a bit	A lot

36. How close do you feel to your **mother**?

1	2	3	4
Not very	Fairly close	Quite close	Extremely close

37. During the past month, how often did your **mother**:

	Never	Once or twice	3 or 4 times	A couple of times a week	Almost every day
a. let you know she really cared?	1	2	3	4	5
b. criticize you or your ideas?	1	2	3	4	5
c. yell at you?	1	2	3	4	5
d. listen carefully to your point of view?	1	2	3	4	5
e. tell you she is proud of the things you do?	1	2	3	4	5
f. argue with you about what you should be doing or how you should act?	1	2	3	4	5
g. do things with you that you enjoy?	1	2	3	4	5
h. argue with you about doing chores or homework?	1	2	3	4	5
i. argue with you about clothes or appearance?	1	2	3	4	5
j. help you do something that was important to you?	1	2	3	4	5

Now answer the following questions about your biological or adoptive father (not your stepfather). If you do not have a father or feel like you can't answer these questions, skip to next section, Social Support, page 42.

38. How much do you want to be like the kind of person your **father** is when you are an adult?

1	2	3	4
Not at all	Just a little	Quite a bit	A lot

39. How much do you respect your **father**?

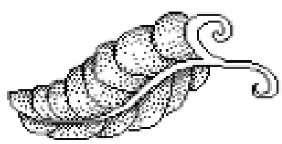
1	2	3	4
Not at all	Just a little	Quite a bit	A lot

40. How close do you feel to your **father**?

1	2	3	4
Not very	Fairly close	Quite close	Extremely close

41. During the past month, how often did your **father**:

	Never	Once or twice	3 or 4 times	A couple of times a week	Almost every day
a. let you know he really cared?	1	2	3	4	5
b. criticize you or your ideas?	1	2	3	4	5
c. yell at you?	1	2	3	4	5
d. listen carefully to your point of view?	1	2	3	4	5
e. tell you he is proud of the things you do?	1	2	3	4	5
f. argue with you about what you should be doing or how you should act?	1	2	3	4	5
g. do things with you that you enjoy?	1	2	3	4	5
h. argue with you about doing chores or homework?	1	2	3	4	5
i. argue with you about clothes or appearance?	1	2	3	4	5
j. help you do something that was important to you?	1	2	3	4	5



SOCIAL SUPPORT

1. When you have a personal problem, how often can you depend on the following people to help you out

Teachers

1	2	3	4	5	6	7
Almost never			Some of the time			All the time

Other adults in school

1	2	3	4	5	6	7
Almost never			Some of the time			All the time

Your parents

1	2	3	4	5	6	7

Almost never | Some of the time | All the time

Your sibling(s)

1	2	3	4	5	6	7
Almost never			Some of the time			All the time

Your friends

1	2	3	4	5	6	7
Almost never			Some of the time			All the time

Other adults outside of school

1	2	3	4	5	6	7
Almost never			Some of the time			All the time

If you circled 4, 5, 6, or 7, above, please explain how you know this person (For example, this person is a teacher, coach, friend of the family, minister/rabbi, etc.): ______________________________

Now think about the adults in your life. Of all the adults you know personally, think of the one you admire the most.

5. Is this person male or female? ______ male ______ female

6. Is this person related to you? ______ yes ______ no

If **yes**, how is this person related to you?

____

If **no**, how do you know this person (For example, this person is a teacher, coach, friend of the family, minister/rabbi, etc.)?

____

7. What are 3 things you admire most about this person?

a) ______________________________

b) ______________________________

c) ______________________________

Now think about other adults you do not know personally but who are famous. Pick the one you admire the most or think of as a "hero".

8. Is this person male or female? ______ male ______ female

9. Who is this person? (Give their full name)

____

10. Tell us what this person does or what this person is best known for?

____

11. What are 3 things you admire most about this person?

a) ____

b) ____

c) ____

BELIEFS ABOUT SELF

1. How often are you:

very good at figuring out problems and planning how to solve them?

1	2	3	4	5	6	7
almost never			sometimes			almost always

very good at carrying out the plans you make for solving problems?

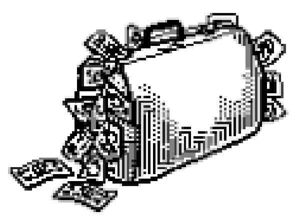
1	2	3	4	5	6	7
almost never			sometimes			almost always

very good at bouncing back quickly from bad experiences?

1	2	3	4	5	6	7
almost never			sometimes			almost always

very good at learning from your mistakes?

1	2	3	4	5	6	7
almost never			sometimes			almost always



If you had a million dollars, what would you most want to do with it?

1)____

2)____

3)____

2. How happy are you with:

the kind of person you are?

1	2	3	4	5	6	7
Not at all happy			Happy			Extremely happy

your closest friends?

1	2	3	4	5	6	7
Not at all happy			Happy			Extremely happy

your popularity?

1	2	3	4	5	6	7
Not at all happy			Happy			Extremely happy

your relationship with your parents?

1	2	3	4	5	6	7
Not at all happy			Happy			Extremely happy

your life now?

1	2	3	4	5	6	7
Not at all happy			Happy			Extremely happy

how well you are doing in your school courses?

1	2	3	4	5	6	7
Not at all happy			Happy			Extremely happy

3. During the last month (including today) how often have you:

felt so angry you wanted to smash or break something?

1	2	3	4	5	6	7
almost never			sometimes			almost always

felt hopeless?

1	2	3	4	5	6	7
almost never			sometimes			almost always

felt that you couldn't control your temper?

1	2	3	4	5	6	7
almost never			sometimes			almost always

felt like you don't care anymore?

1	2	3	4	5	6	7
almost never			sometimes			almost always

felt very sad?

1	2	3	4	5	6	7
almost never			sometimes			almost always

felt depressed?

1	2	3	4	5	6	7
almost never			sometimes			almost always

felt so upset you wanted to hit or hurt someone?

1	2	3	4	5	6	7
almost never			sometimes			almost always

had thoughts of ending your life?

1	2	3	4	5	6	7
almost never			sometimes			almost always

felt really unhappy because it seemed like nobody wanted you as a friend?

1	2	3	4	5	6	7
almost never			sometimes			almost always

Think about the last 6 months. About how often in those 6 months did you do the things listed below?

skip a day of school?

____ never	____ 2-3 times	____ 11-20 times
____ once	____ 4-6 times	____ 21-30 times

____ 7-10 times ____ 31 or more times

do something you knew was dangerous just for the thrill of it?

____ never ____ 2-3 times ____ 11-20 times
____ once ____ 4-6 times ____ 21-30 times
____ 7-10 times ____ 31 or more times

have contact with the police for something you did or that they thought you did?

____ never ____ 2-3 times ____ 11-20 times
____ once ____ 4-6 times ____ 21-30 times
____ 7-10 times ____ 31 or more times

damage public or private property?

____ never ____ 2-3 times ____ 11-20 times
____ once ____ 4-6 times ____ 21-30 times
____ 7-10 times ____ 31 or more times

get drunk?

____ never ____ 2-3 times ____ 11-20 times
____ once ____ 4-6 times ____ 21-30 times
____ 7-10 times ____ 31 or more times

stay out all night without your parents' permission?

____ never ____ 2-3 times ____ 11-20 times
____ once ____ 4-6 times ____ 21-30 times
____ 7-10 times ____ 31 or more times

get suspended from school?

____ never ____ 2-3 times ____ 11-20 times
____ once ____ 4-6 times ____ 21-30 times
____ 7-10 times ____ 31 or more times

disobey your parents on an important issue?

____ never ____ 2-3 times ____ 11-20 times
____ once ____ 4-6 times ____ 21-30 times
____ 7-10 times ____ 31 or more times

do some pretty risky things because it was a real kick?

____ never ____ 2-3 times ____ 11-20 times
____ once ____ 4-6 times ____ 21-30 times
____ 7-10 times ____ 31 or more times

lie to your parents about something important?

____ never ____ 2-3 times ____ 11-20 times
____ once ____ 4-6 times ____ 21-30 times
____ 7-10 times ____ 31 or more times

get into a fist fight with another kid?

____ never ____ 2-3 times ____ 11-20 times
____ once ____ 4-6 times ____ 21-30 times
____ 7-10 times ____ 31 or more times

drink alcohol?

____ never ____ 2-3 times ____ 11-20 times
____ once ____ 4-6 times ____ 21-30 times
____ 7-10 times ____ 31 or more times

get sent to the principal's office or assistant principal's office?

____ never ____ 2-3 times ____ 11-20 times

get sent to the principal's office or assistant principal's office?

____ never ____ 2-3 times ____ 11-20 times
____ once ____ 4-6 times ____ 21-30 times
____ 7-10 times ____ 31 or more times

In the chart below, please **circle a Yes or No** to indicate whether you have taken or plan to take any of these classes or activities in the 10th, 11th, or 12th grades.

	10TH GRADE	11TH GRADE	12TH GRADE
MATH	Yes No	Yes No	Yes No
ENGLISH	Yes No	Yes No	Yes No
VOCATIONALLY RELATED COURSES (For example: Wood shop, Electronics, Typing, Work Experience, etc.)	Yes No	Yes No	Yes No
INSTRUMENTAL MUSIC/BAND	Yes No	Yes No	Yes No
VOCAL MUSIC/CHOIR	Yes No	Yes No	Yes No

Are you planning to take mostly (Check one):

_____ College preparatory courses
_____ Vocational courses
If you checked this, what special interest do you have:
____

_____ About an equal amount of college preparatory and vocational courses

Are there any other classes you are planning to take that are relevant to your career goals? _______ yes ________ no

If yes, what are they (please be specific)?

____
____

Are there any competitive sports you plan to try out for or participate in while in high school?
_____ yes _____ no

If yes, which sport(s) do you plan to do (list all)?

____
____
____

Are there any noncompetitive sports you plan to participate in while in high school?

_____ yes _____ no

If yes, which sport(s) do you plan to do (list all)?

____

____

____

Are there any school organizations, clubs, or other school activities you plan to join while in high school?

_____ yes _____ no

If yes, which organizations, clubs, or activities (list all)?

____

____

____

BACKGROUND INFORMATION

If your parents are married to each other, please go to the last page, page 54.

If your parents are divorced, separated, or deceased, please answer the following questions:

1. How long have your parents been divorced, separated, or widowed?

___ Less than 6 months ___ 1 to 3 years ___ 6 to 10 years
___ 6 months to 1 year ___ 3 to 6 years ___ Over 10 years

2. Which parent do you live with?

____ Mother ___ Father

____ Both (about equal time living with each person)

____ Other (specify) ____

3. Is the parent you live with remarried? ____ yes ____ no

If no, go to question #8.

If yes, how long have they been remarried (check one)? ___ Less than 1 year
___ 1-3 years
___ more than 3 years

If yes, do any stepbrothers or stepsisters live with you? ____ yes ____ no

If yes, answer the following questions about the stepparent you live with.

Is this person your (Circle one): Stepmom Stepdad Other

4. How much do you want to be like the kind of person the **stepparent** you live with is when you are an adult?

1	2	3	4
Not at all	Just a little	Quite a bit	A lot

5. How much do you respect the **stepparent** you live with?

1	2	3	4
Not at all	Just a little	Quite a bit	A lot

6. How close do you feel to the **stepparent** you live with?

1	2	3	4
Not very	Fairly close	Quite close	Extremely close

7. During the past month, how often did the **stepparent** you live with:

Once or	3 or 4	A couple of times	Almost

	Never	twice	times	a week	every day
a. let you know s/he really cared?	1	2	3	4	5
b. criticize you or your ideas?	1	2	3	4	5
c. yell at you?	1	2	3	4	5
d. listen carefully to your point of view?	1	2	3	4	5
e. tell you s/he is proud of the things you do?	1	2	3	4	5
f. argue with you about what you should be doing or how you should act?	1	2	3	4	5
g. do things with you that you enjoy?	1	2	3	4	5
h. argue with you about doing chores or homework?	1	2	3	4	5
i. argue with you about clothes or appearance	1	2	3	4	5
j. help you do something that was important to you	1	2	3	4	5

If your other parent is deceased, skip to the last page, page 54.
If your other parent is alive, please continue.
8. How often do you see the parent you do not live with (Check only one):

____ Frequently (3 to 4 days a week or more)

____ At least once a week

____ A couple of days a week every other week

____ About once a month

____ At least once per year for a week or more

____ Not very often

____ Never

9. Is the parent you do not live with remarried ____ yes ____ no

If no, go to last page, page 54.

If yes, how long have they been remarried (check one)? ___ Less than 1 year ___ 1-3 years ___ more than 3 years

If yes, answer the following questions about the stepparent you do not live with.

Is this person your (Circle one): Stepmom Stepdad Other

10. How much do you want to be like the kind of person the **stepparent** you do not live with is when you are an adult?

1	2	3	4
Not at all	Just a little	Quite a bit	A lot

11. How much do you respect the **stepparent** you do not live with?

1	2	3	4
Not at all	Just a little	Quite a bit	A lot

12. How close do you feel to the **stepparent** you do not live with?

1	2	3	4
Not very	Fairly close	Quite close	Extremely close

13. During the past month, how often did the **stepparent** you do not live with:

	Never	Once or twice	3 or 4 times	A couple of times a week	Almost every day
a. let you know s/he really cared?	1	2	3	4	5
b. criticize you or your ideas?	1	2	3	4	5
c. yell at you?	1	2	3	4	5
d. listen carefully to your point of view?	1	2	3	4	5
e. tell you s/he is proud of the things you do?	1	2	3	4	5
f. argue with you about what you should be doing or how you should act?	1	2	3	4	5
g. do things with you that you enjoy?	1	2	3	4	5
h. argue with you about doing chores or homework?	1	2	3	4	5
i. argue with you about clothes or appearance	1	2	3	4	5
j. help you do something that was important to you	1	2	3	4	5

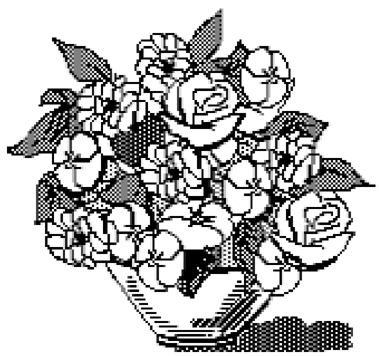
We have just a few final questions to ask you. Are there any questions we did not ask that you think may be important in understanding kids and their school experiences?

____

____

____

Are there any questions we did not ask that you think may be important in understanding kids and their parents?



THANK YOU! THANK YOU!

Appendix C: Mathematics, Science, and Technology (MST) Survey

Math, Science, Technology (MST)

Self-Concept Survey

Student Name: ______________________________

Directions:
The Center School District is interested in knowing how you feel about math, science, and technology. You will be asked several questions about your feelings and attitudes towards these subjects. For each question, choose the number that matches how you feel. You can only circle one number per question. Your answers will be kept private and will not be shared with your teacher.

Here is an example using **music**:

How good at **music** are you?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

Student Code: ____________________________

MATH

1. How good at **math** are you?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

2. Some students find that they are better at one subject or activity than another. Compared to most of your other activities, how good are you at **math**?

1	2	3	4	5	6	7
Not as good as other activities			About the same			A lot better than other activities

3. If you were to list all the students in your grade from the worst to the best in **math**, where would you put yourself?

1	2	3	4	5	6	7
One of the worst			In the middle			The best

4. How well do you expect to do in **math** next year?

1	2	3	4	5	6	7
Not at all well			O.K.			Very well

5. How good would you be at learning something new in **math**?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

6. In general, how useful is what you learn in **math**?

1	2	3	4	5	6	7
Not at all useful			Somewhat useful			Very useful

7. Some students find what they learn in one subject or activity more useful than what they learn in another. Compared to most of your other activities, how useful is what you learn in **math**?

1	2	3	4	5	6	7
Not as useful as what I learn in other activities			About the same			A lot more useful than what I learn in other activities

8. For me, being good at **math** is

1	2	3	4	5	6	7
Not at all important			Somewhat important			Very important

9. Some students believe that it is more important to be better at one subject or activity than another. Compared to most of your other activities, how important is it to you to be good at **math**?

1	2	3	4	5	6	7
Not as important as what I learn in other activities			About the same			A lot more important than what I learn in other activities

10. How much do you like doing **math**?

1	2	3	4	5	6	7
A little			Some			A lot

11. Some students find that they like one subject or activity much more than another. Compared to most of your other activities, how much do you like **math**?

1	2	3	4	5	6	7
Not as much as other activities			About the same			A lot more than other activities

12. In general, I find working on **math** assignments

1	2	3	4	5	6	7
Very boring			O.K.			Very interesting (very fun)

13. How often do you wish you were doing something else when you do **math**?

1	2	3	4	5	6	7
Never			Sometimes			Almost every day

SCIENCE

1. How good at **science** are you?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

2. Compared to most of your other activities, how good are you at **science**?

1	2	3	4	5	6	7
Not as good as other activities			About the same			A lot better than other activities

3. If you were to list all the students in your grade from the worst to the best in **science**, where would you put yourself?

1	2	3	4	5	6	7
One of the worst			In the middle			The best

4. How well do you expect to do in **science** next year?

1	2	3	4	5	6	7
Not at all well			O.K.			Very well

5. How good would you be at learning something new in **science**?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

6. In general, how useful is what you learn in **science**?

1	2	3	4	5	6	7
Not at all useful			Somewhat useful			Very useful

7. Compared to most of your other activities, how useful is what you learn in **science**?

1	2	3	4	5	6	7
Not as useful as what I learn in other activities			About the same			A lot more useful than what I learn in other activities

8. For me, being good at **science** is

1	2	3	4	5	6	7
Not at all important			Somewhat important			Very important

9. Compared to most of your other activities, how important is it to you to be good at **science**?

1	2	3	4	5	6	7
Not as important as what I learn in other activities			About the same			A lot more important than what I learn in other activities

10. How much do you like doing **science**?

1	2	3	4	5	6	7
A little			Some			A lot

11. Compared to most of your other activities, how much do you like **science**?

1	2	3	4	5	6	7
Not as much as other activities			About the same			A lot more than other activities

12. In general, I find working on **science** assignments

1	2	3	4	5	6	7
Very boring			O.K.			Very interesting (very fun)

13. How often do you wish you were doing something else when you do **science**?

1	2	3	4	5	6	7
Never			Sometimes			Almost every day

Technology

Technology is any type of computer device. Examples of technology: desktop or laptop computer, iPad or other tablet, Chromebook, smart phone.

1. How good at **technology** are you?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

2. Compared to most of your other activities, how good are you at **technology**?

1	2	3	4	5	6	7
Not as good as other activities			About the same			A lot better than other activities

3. If you were to list all the students in your grade from the worst to the best in **technology**, where would you put yourself?

1	2	3	4	5	6	7
One of the worst			In the middle			The best

4. How well do you expect to do in **technology** next year?

1	2	3	4	5	6	7
Not at all well			O.K.			Very well

5. How good would you be at learning something new in **technology**?

1 2 3 4 5 6 7
Not at all good — O.K. — Very good

6. In general, how useful is what you learn in **technology**?

1 2 3 4 5 6 7
Not at all useful — Somewhat useful — Very useful

7. Compared to most of your other activities, how useful is what you learn in **technology**?

1 2 3 4 5 6 7
Not as useful as what I learn in other activities — About the same — A lot more useful than what I learn in other activities

8. For me, being good at **technology** is

1 2 3 4 5 6 7
Not at all important — Somewhat important — Very important

9. Compared to most of your other activities, how important is it to you to be good at **technology**?

1 2 3 4 5 6 7
Not as important as what I learn in other activities — About the same — A lot more important than what I learn in other activities

10. How much do you like doing **technology**?

1 2 3 4 5 6 7
A little — Some — A lot

11. Compared to most of your other activities, how much do you like **technology**?

1	2	3	4	5	6	7
Not as much as other activities			About the same			A lot more than other activities

12. In general, I find working on **technology** assignments

1	2	3	4	5	6	7
Very boring			O.K.			Very interesting (very fun)

13. How often do you wish you were doing something else when you do **technology**?

1	2	3	4	5	6	7
Never			Sometimes			Almost every day

Appendix D: Email Receiving Permission to Modify Survey

From: Meeta Banerjee <mbanerje@umich.edu>
Subject: Re: Self-Concept & Student Interest Survey
Date: August 3, 2015 at 6:44:15 PM CDT
To: Tyler Shannon <tshannon@center.k12.mo.us>

Hi Tyler,
Thanks for contacting me. As you may know, the surveys themselves are located on the Gender and Achievement Research Program's website. I asked Dr. Eccles if you had permission to use them, and she said yes and good luck. You can access the website on http://www.rcgd.isr.umich.edu/garp/

And you can access the surveys at http://www.rcgd.isr.umich.edu/cab/ and go to questionnaires.

I hope this helps and good luck.
Sincerely,
Meeta Banerjee, MSW, Ph.D.
Research Specialist
School of Education
University of California-Irvine
Research Fellow
Research Center for Group Dynamics
Achievement Research Lab
Institute for Social Research
University of Michigan
5112 ISR
426 Thompson St.
Ann Arbor, MI
48106-1248
mbanerje@umich.edu

On Mon, Aug 3, 2015 at 10:33 AM, Tyler Shannon <tshannon@center.k12.mo.us> wrote:

> Dr. Banerjee,
>
> I am a doctoral student at Baker University and wanting to study self-concept and interest. My research will look at self-concept and interest as it pertains to Project Lead the Way, particularly PLTW's new elementary curriculum. I am hoping to gain permission to use the CAB survey. I would like to use questions connected to mathematics, science, and technology. If necessary, I would like permission to make a few modifications to the technology related questions. An example of a modification would be:
>
> Original Question: How good are you on the computer?
>
> Modification: How good are you with technology?
>
> I appreciate your consideration. I can be reached at 816.876.8166 if you have further questions and would like to discuss this over the phone.
>
> Sincerely,
>
> Tyler P. Shannon
> Principal
> Red Bridge Elementary
> Kansas City, MO

Appendix E: Submitted IRB to Baker University

BAKER UNIVERSITY

School of education
Graduate department

IRB PROTOCOL NUMBER ____________
(irb USE ONLY)

Date: March, 26, 2016

IRB Request
Proposal for Research
Submitted to the Baker University Institutional Review Board

I. Research Investigator(s) (Students must list faculty sponsor first)

Department(s) **School of Education Graduate Department**

Name	Signature	
1. Dr. Susan Rogers	Susan Rogers	Major Advisor
2. Dr. Phillip Messner	Phillip Messner	Research Analyst
3. Dr. Sharon Zoellner		University Committee Member
4.		External Committee Member

Principal Investigator: Tyler Shannon
Phone: 816-876-8166
Email: tshannon@center.k12.mo.us
Mailing address: 9328 NE 97th St., Kansas City, MO 64157

Faculty sponsor: Dr. Susan Rogers
Phone: 913-344-1226 (OP office) 785-230-2801 (Mobile)
Email: srogers@bakeru.edu

Expected Category of Review: __X_Exempt ___ Expedited _ __Full

II: Protocol: (Type the title of your study)

The Change in Student Self-Concept, Values/Importance, and Interest in Science, Mathematics, and Technology after Project Lead the Way Launch Implementation

Summary

In a sentence or two, please describe the background and purpose of the research.

The study will take place in the Center School District in Kansas City, MO. The sample will consist of fifth grade students from two elementary schools in the district. The first purpose of this study will be to determine if implementation of PLTW Launch affects students' self-concept, value/importance, and interest in mathematics, science, and technology. A second purpose will be to determine if there is a difference in student's self-concept, value/importance, and interest in mathematics, science, and technology between genders.

Briefly describe each condition or manipulation to be included within the study.

There are no conditions or manipulations included within in this study.

What measures or observations will be taken in the study? If any questionnaire or other instruments are used, provide a brief description and attach a copy. Will the subjects encounter the risk of psychological, social, physical or legal risk? If so, please describe the nature of the risk and any measures designed to mitigate that risk.

I will use archival data collected from a modified survey that was originally created by Jacquelynne Eccles from the University of Michigan. The original survey was created for the Childhood and Beyond Project, which studied students' self-concept, interest, and value/importance. The modified survey consists of 39 questions. Each question is on a 1 to 7-Likert-type response scale. There are three sections to the survey: mathematics, science, and technology. The survey will take no more than 30 minutes for students to complete. See attached survey. No subjects will encounter the risk of psychological, social, physical, or legal risk.

Will any stress to subjects be involved? If so, please describe.

No stress to any subjects will be involved within this study.

Will the subjects be deceived or misled in any way? If so, include an outline or script of the debriefing.

No subjects will be deceived or misled in any way.

Will there be a request for information which subjects might consider to be personal or sensitive? If so, please include a description.

No requests will be made for personal or sensitive information for subjects within this study.

Will the subjects be presented with materials which might be considered to be offensive, threatening, or degrading? If so, please describe.

No subjects will be presented with materials that might be considered offensive, threatening, or degrading.

Approximately how much time will be demanded of each subject?

There is no time commitment due to archival data being used.

Who will be the subjects in this study? How will they be solicited or contacted? Provide an outline or script of the information which will be provided to subjects prior to their volunteering to participate. Include a copy of any written solicitation as well as an outline of any oral solicitation.

The subjects for this study will be fifth grade students during the 2015-2016 school year at Center Elementary and Red Bridge Elementary in the Center School District.

The participants will not be solicited due to the data being archival.

What steps will be taken to insure that each subject's participation is voluntary? What if any inducements will be offered to the subjects for their participation?

It is archival data, therefore no consent is needed and no inducements will be offered.

How will you insure that the subjects give their consent prior to participating? Will a written consent form be used? If so, include the form. If not, explain why not.

In this study, no consent is needed due to the study using archival data.

Will any aspect of the data be made a part of any permanent record that can be identified with the subject? If so, please explain the necessity.

In this study, the data will not be made a part of any permanent record that can be identified with the subject.

Will the fact that a subject did or did not participate in a specific experiment or study be made part of any permanent record available to a supervisor, teacher or employer? If so, explain.

In this study, the fact that a subject did or did not participate in the study will not be made part of any permanent record available to a supervisor, teacher, or employer.

What steps will be taken to insure the confidentiality of the data? Where will it be stored? How long will it be stored? What will be done with it after the study is completed?

Student data will be retrieved in such a way that random numbers will be assigned to students to ensure all identifying factors have been eliminated. Data will be stored on a password protected Google Drive. The data will be stored in the Google Drive for one year after the study is completed. The data will be deleted from the password protected Google Drive when the study is completed and one year has passed.

If there are any risks involved in the study, are there any offsetting benefits that might accrue to either the subjects or society?

There are no risks involved in this study.

Will any data from files or archival data be used? If so, please describe.

Archival data will be collected from the Center School District. The archival data was collected by the Center School District during the 2015-2016 school year to see if Project Lead the Way Launch curriculum was effective in changing student attitudes towards mathematics, science, and technology.

Math, Science, Technology (MST)

Self-Concept Survey

Student Name: ______________________________

Directions:
The Center School District is interested in knowing how you feel about math, science, and technology. You will be asked several questions about your feelings and attitudes towards these subjects. For each question, choose the number that matches how you feel. You can only circle one number per question. Your answers will be kept private and will not be shared with your teacher.

Here is an example using **music**:

How good at **music** are you?

1	2	3	4	5	6	7
Not at all good		O.K.			Very good	

Student Code: ________________________________

MATH

1. How good at **math** are you?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

2. Some students find that they are better at one subject or activity than another. Compared to most of your other activities, how good are you at **math**?

1	2	3	4	5	6	7
Not as good as other activities			About the same			A lot better than other activities

3. If you were to list all the students in your grade from the worst to the best in **math**, where would you put yourself?

1	2	3	4	5	6	7
One of the worst			In the middle			The best

4. How well do you expect to do in **math** next year?

1	2	3	4	5	6	7
Not at all well			O.K.			Very well

5. How good would you be at learning something new in **math**?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

6. In general, how useful is what you learn in **math**?

1	2	3	4	5	6	7
Not at all useful			Somewhat useful			Very useful

7. Some students find what they learn in one subject or activity more useful than what they learn in another. Compared to most of your other activities, how useful is what you learn in **math**?

1	2	3	4	5	6	7
Not as useful as what I learn in other activities			About the same			A lot more useful than what I learn in other activities

8. For me, being good at **math** is

1	2	3	4	5	6	7
Not at all important			Somewhat important			Very important

9. Some students believe that it is more important to be better at one subject or activity than another. Compared to most of your other activities, how important is it to you to be good at **math**?

1	2	3	4	5	6	7
Not as important as what I learn in other activities			About the same			A lot more important than what I learn in other activities

10. How much do you like doing **math**?

1	2	3	4	5	6	7
A little			Some			A lot

11. Some students find that they like one subject or activity much more than another. Compared to most of your other activities, how much do you like **math**?

1	2	3	4	5	6	7
Not as much as other activities			About the same			A lot more than other activities

12. In general, I find working on **math** assignments

1	2	3	4	5	6	7
Very boring			O.K.			Very interesting (very fun)

13. How often do you wish you were doing something else when you do **math**?

1	2	3	4	5	6	7
Never			Sometimes			Almost every day

SCIENCE

1. How good at **science** are you?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

2. Compared to most of your other activities, how good are you at **science**?

1	2	3	4	5	6	7
Not as good as other activities		About the same			A lot better than other activities	

3. If you were to list all the students in your grade from the worst to the best in **science**, where would you put yourself?

1	2	3	4	5	6	7
One of the worst			In the middle			The best

4. How well do you expect to do in **science** next year?

1	2	3	4	5	6	7
Not at all well			O.K.			Very well

5. How good would you be at learning something new in **science**?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

6. In general, how <u>useful</u> is what you learn in **science**?

1	2	3	4	5	6	7
Not at all useful			Somewhat useful			Very useful

7. <u>Compared to most of your other activities</u>, how <u>useful</u> is what you learn in **science**?

1	2	3	4	5	6	7
Not as useful as what I learn in other activities			About the same			A lot more useful than what I learn in other activities

8. For me, <u>being good</u> at **science** is

1	2	3	4	5	6	7
Not at all important			Somewhat important			Very important

9. <u>Compared to most of your other activities</u>, how <u>important</u> is it to you <u>to be good</u> at **science**?

1	2	3	4	5	6	7
Not as important as what I learn in other activities			About the same			A lot more important than what I learn in other activities

10. How much do you <u>like</u> doing **science**?

1	2	3	4	5	6	7
A little			Some			A lot

11. Compared to most of your other activities, how much do you like **science**?

1	2	3	4	5	6	7
Not as much as other activities			About the same			A lot more than other activities

12. In general, I find working on **science** assignments

1	2	3	4	5	6	7
Very boring			O.K.			Very interesting (very fun)

13. How often do you wish you were doing something else when you do **science**?

1	2	3	4	5	6	7
Never			Sometimes			Almost every day

Technology

Technology is any type of computer device. Examples of technology: desktop or laptop computer, iPad or other tablet, Chromebook, smart phone.

1. How good at **technology** are you?

1	2	3	4	5	6	7
Not at all good			O.K.			Very good

2. Compared to most of your other activities, how good are you at **technology**?

1	2	3	4	5	6	7
Not as good as other activities		About the same			A lot better than other activities	

3. If you were to list all the students in your grade from the worst to the best in **technology**, where would you put yourself?

1	2	3	4	5	6	7
One of the worst			In the middle			The best

4. How well do you expect to do in **technology** next year?

1	2	3	4	5	6	7
Not at all well			O.K.			Very well

5. How good would you be at learning something new in **technology**?

1 2 3 4 5 6 7
Not at all good   O.K.   Very good

6. In general, how useful is what you learn in **technology**?

1 2 3 4 5 6 7
Not at all useful   Somewhat useful   Very useful

7. Compared to most of your other activities, how useful is what you learn in **technology**?

1 2 3 4 5 6 7
Not as useful as what I learn in other activities   About the same   A lot more useful than what I learn in other activities

8. For me, being good at **technology** is

1 2 3 4 5 6 7
Not at all important   Somewhat important   Very important

9. Compared to most of your other activities, how important is it to you to be good at **technology**?

1 2 3 4 5 6 7
Not as important as what I learn in other activities   About the same   A lot more important than what I learn in other activities

10. How much do you like doing **technology**?

1 2 3 4 5 6 7
A little   Some   A lot

11. Compared to most of your other activities, how much do you like **technology**?

1	2	3	4	5	6	7
Not as much as other activities			About the same			A lot more than other activities

12. In general, I find working on **technology** assignments

1	2	3	4	5	6	7
Very boring			O.K.			Very interesting (very fun)

13. How often do you wish you were doing something else when you do **technology**?

1	2	3	4	5	6	7
Never			Sometimes			Almost every day

Appendix F: IRB Approval from Baker University

Baker University Institutional Review Board

April 12, 2016

Dear Tyler Shannon and Dr. Rogers,

The Baker University IRB has reviewed your research project application and approved this project under Exempt Status Review. As described, the project complies with all the requirements and policies established by the University for protection of human subjects in research. Unless renewed, approval lapses one year after approval date.

Please be aware of the following:

1. Any significant change in the research protocol as described should be reviewed by this Committee prior to altering the project.
2. Notify the IRB about any new investigators not named in original application.
3. When signed consent documents are required, the primary investigator must retain the signed consent documents of the research activity.
4. If this is a funded project, keep a copy of this approval letter with your proposal/grant file.
5. If the results of the research are used to prepare papers for publication or oral presentation at professional conferences, manuscripts or abstracts are requested for IRB as part of the project record.

Please inform this Committee or myself when this project is terminated or completed. As noted above, you must also provide IRB with an annual status report and receive approval for maintaining your status. If you have any questions, please contact me at CTodden@BakerU.edu or 785.594.8440.

Sincerely,

Chris Todden EdD
Chair, Baker University IRB

Baker University IRB Committee
Verneda Edwards EdD
Sara Crump PhD
Erin Morris PhD
Scott Crenshaw