MALE AND FEMALE MIDDLE SCHOOL STUDENTS' ATTITUDES TOWARD SCIENCE

by

Michelle Lynn Schpakow

Liberty University

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

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ABSTRACT

Women continue to be underrepresented in certain disciplines of science. Differences in male and female students' attitudes toward science have been observed down to the middle school level. Attitudes, however, may be formed through the integration of multiple constructs: attitudes toward school science, desire to become a scientist, value of science to society, and perceptions of scientists. To fully understand the problem of the underrepresentation of females in science, differences in male and female middle school students' attitudes toward science were analyzed across these constructs. A causal-comparative design was used to compare students' attitudes toward science based on biological sex. The students responded to Likert-type items on the My Attitudes Toward Science survey during their regularly scheduled science class periods. The sample included sixth, seventh, and eighth grade science students in middle schools located in suburban central New Jersey. Data analysis was performed through a multivariate analysis of variance. The findings indicated no significant difference exists in middle school students' attitudes toward school science, desire to become a scientist, value of science to society, and perceptions of scientists based on biological sex of the students.

Keywords: attitudes, middle school, science, gender gap

Dedication

I would like to dedicate this dissertation to my family who supported me throughout my education. Gregory, you were made to be my partner in life and have never complained about doing more than your share when I most need help. For all you do for me and the family we've created together, I thank you. I pray that my children learn to pursue their dreams and recognize that challenges only make the rewards more worthwhile. I hope each of you grows to love learning as much as I have. To my brother Greg, your constant belief in me drives me to work harder and believe in myself. Finally, I thank my parents for a lifetime of love. Daddy, you've always been the wind beneath my wings, lifting me up so that I could reach my dreams. Mommy, you are the role model that I continue to look up to, always working to become as strong a woman, as smart an individual, and as caring a mother as you are. To my family, I love you and thank you.

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CHAPTER ONE: INTRODUCTION

Overview

Chapter One will introduce the background related to middle school students' attitudes toward science based on biological sex. The problem statement will be discussed and include research recommendations from previous studies. The purpose and significance of the proposed study will be discussed. The research question will be introduced, and definitions central to the study will be provided.

Background

The underrepresentation of women in science has gained the attention of educational researchers for more than four decades (Buck, Cook, Quigley, Prince, & Lucas, 2014; Bybee & McCrae, 2011; Naizer, Hawthorne, & Henley, 2014; Osborne, Simon, & Collins, 2003). This inequality in science, referred to in the literature as the *gender gap*, has been studied at different levels of schooling and through different contexts. Engagement and achievement differences between male and female students have been the focus of numerous studies while student attitudes have been the focus of others (Naizer et al., 2014).

Though female students tend to show less interest in science than male students, the gender gap is not prevalent in every grade level (Naizer et al., 2014; Smith, Pasero, & McKenna, 2014). Elementary-aged female students perform similarly to male students in math and science (Naizer et al., 2014). The female students lose interest in science as they get older with significant differences noticeable in middle and high school (Naizer et al., 2014). During the course of the last 40 years, researchers and educators alike have attempted to minimize this gender gap by initiating programs, interventions, curriculum changes, and new pedagogy with the goal of improving female students' attitudes toward science.

Some intervention programs offered have been found to improve female students' attitudes toward science. Buck et al. (2014) studied female elementary school students' attitude changes after their experience in a true laboratory classroom with a trained laboratory science teacher. This teacher worked alongside the classroom science teachers and provided new experiences for the students (Buck et al., 2014). Female students' attitudes toward the subject improved as a result (Buck et al., 2014). Naizer et al. (2014) found a similar improvement in attitudes for female students after participation in a summer engineering program. When the girls were exposed to engineering practices, their self-efficacy and general interest in this domain of science increased (Naizer et al., 2014).

Current studies on sex differences in science achievement report mixed results with some documenting no significant difference and others documenting a persistent but small difference in achievement between male and female students across grade levels (Baram-Tsabari & Yarden, 2011; Curran & Kellogg, 2016; Quinn & Cooc, 2015; Reilly, Neumann, & Andrews, 2015). Though the gender gap may be less persistent in science achievement among current students, Baram-Tsabari and Yarden (2011) found that it still exists in student interest. A study of students in kindergarten through twelfth grade revealed no difference in science interests for young children, but by third grade, female students already began showing more interest in biological sciences while males preferred physical science and technology (Baram-Tsabari & Yarden, 2011). Though male and female students showed different preferences within the sciences, male students did not have more positive attitudes than females overall (Baram-Tsabari & Yarden, 2011).

Baram-Tsabari and Yarden (2011) state that "intellectually talented males and females are both achieving high goals by their mid-30s" but that their achievements are in different areas of science (p. 540). Similarly, Wang and Degol (2017) explained women are no longer underrepresented in all fields of science; instead, there are only some career fields lacking women. Kennedy, Lyons, and Quinn (2014) found a difference in the science course subjects in which high school students enrolled. Like other studies, they found more males in physics than females. In contrast to other researchers, however, Kennedy et al. found enrollment proportions of young men increasing in biology while young women were becoming more common in Earth sciences. Overall, the enrollment trend shows a decline in male and female students choosing to pursue science courses in high school (Kennedy et al., 2014).

In developed countries, both male and female students have been found to be uninterested in pursuing careers in science when compared with students in developing countries (Jenkins & Nelson, 2005; Un-Nisa, Sarwar, Naz, & Noreen, 2011). Of the students choosing to pursue science degree programs and eventual careers, male and female students differ in the disciplines of science in which they engage. The percentage of women in health professions, veterinary medicine, and biology equal or surpass that of men (Jones, Howe, & Rua, 2000; Wang & Degol, 2017). Men outnumber women, however, in professions such as technology, mathematics, and physical sciences (Wang & Degol, 2017).

Differences in the perceived value of science to society based on biological sex are more contradictory in the literature. Overall, students appear to view science as valuable for society (Desy, Peterson, & Brockman, 2011; George, 2003; George, 2006; Kim & Song, 2009). Female students recognize the utility of science more readily than male students (Blanchard Kyte & Riegle-Crumb, 2017; Else-Quest, Mineo, & Higgins, 2013). Female students with a greater appreciation for the value of science are more likely to pursue science as a career than those who do not recognize its value (Blanchard Kyte & Riegle-Crumb, 2017). Career choice in male students, however, does not appear to be affected by the perception of science utility (Blanchard Kyte & Riegle-Crumb, 2017).

The lack of women in science is also related to children's perceptions of stereotypical scientist traits (Hillman, Zeeman, Tilburg, & List, 2016). Children observe their environments and role models as they get older to determine what roles, behaviors, and careers are considered acceptable for each biological sex (Weisgram & Bigler, 2006). Career fields that are considered masculine, such as technology and physics, deter female students from engaging in them (Francis et al., 2017; Weisgram & Bigler, 2006). Children grow to believe the humanities are considered acceptable for women whereas most sciences are not suited for women (Liu, Hu, Jiannong, & Adey, 2010). Stereotypical perceptions increase in magnitude for males and females as they get older, but the perceptions are stronger overall for female students (Liu et al., 2010).

The influence of role models such as female teachers, female scientists, and the opinions of friends and family members can play a significant role in the self-perceptions of female science students (Gokhale, Rabe-Hemp, Woeste, & Machina, 2015; Ing, 2014; Ochsenfeld, 2016). Higher numbers of female science and mathematics teachers in high schools increases the number of female students pursuing these subjects in college without decreasing the number of male students studying these subjects (Stearns et al., 2016). Farland-Smith (2009) found female students' attitudes to be improved when the students were afforded the opportunity to work with actual scientists.

It is important to gain an understanding of current students' attitudes toward science. If a gender gap still exists in student attitudes, it is logical to believe the underrepresentation of women in scientific career fields will persist. If this is the case, women may be disadvantaged and have less earning potential than men (Oh & Lewis, 2011; Xu, 2015). The scientific community will also suffer because the creativity and intelligence of many young women will be unrealized if they do not pursue careers in this field.

Students' attitudes toward science and ultimate desire to pursue scientific careers can be explained by expectancy-value theory. This theory asserts that students' future endeavors in a given field are determined by an interplay of two factors: the students' expectancy for success and their perceived value of the task (Wigfield & Eccles, 2000). Students are more willing to pursue fields in which they believe they will succeed (Wigfield & Eccles, 2000). Students are also more willing to pursue fields they perceive to be valuable (Wigfield & Eccles, 2000).

Gender theories provide an explanation for differences in students' attitudes toward science based on biological sex. Biosocial constructionist theory suggests the division in labor for males and females stems from biological differences (Eagly & Wood, 2013). The physical size and strength of men differs from the maternal instincts of women making each sex more efficient in performing different social roles (Eagly & Wood, 2013). According to Martin Halverson's gender schema theory (1981), male and female students learn the roles, behaviors, and interests most aligned with their biological sex through observations of their society (Weisgram & Bigler, 2006). Society suggests that science is a male domain which causes female students to believe science is not for them (Weisgram & Bigler, 2006).

The future pursuit of science is largely tied to students' expectations for success. Bandura's social cognitive theory (1997) explains that students' expectancy values are determined by their self-efficacy in the subject (Ross, Scott, & Bruce, 2012). As students get older, they increasingly believe the stereotype that science is a masculine domain (Liu et al., 2010). Female students believe this stereotype which reduces their self-efficacy in science. As a result their expectancy values decrease preventing them from pursuing science during later schooling or as a career.

Problem Statement

As science and technology continue to race forward, college graduates ready to pursue scientific career fields are in demand. Students are losing interest in science, however, with female students losing interest at an accelerated rate (Braund & Reiss, 2006; Cady & Terrell, 2008; Kennedy et al., 2014; Naizer et al., 2014). Literature spanning over 40 years of research document the gender gap in science which tends to manifest in the middle grades, but no single conclusion exists to explain the phenomenon (Baram-Tsabari & Yarden, 2011; Naizer et al., 2014; Wang & Degol, 2017).

The United States has initiated educational reform in science by developing a set of standards to be used across states. The Next Generation Science Standards (NGSS) were created to increase the competency of American students in science, ultimately preparing them to fill roles in future science-related careers (NGSS Lead States, 2013). Though the standards are meant to provide better foundations in science to today's students, the need for future scientists may not be filled if students do not retain their interests in scientific endeavors. The differences in attitudes toward science of male and female middle school students, therefore, is worthwhile reexamining in current middle schools.

Current studies have focused on specific programs implemented within schools or pedagogical practices of teachers that are meant to encourage female student participation in science (Buck et al., 2014; Machina & Gokhale, 2009; Naizer et al., 2014). Similarly, many studies focus their attention on increasing female student achievement in science (Else-Quest et al., 2013; Lee, Hayes, Seitz, DiStefano, & O'Connor, 2016; Perera, 2014; Quinn & Cooc, 2015;

Wolf & Fraser, 2008). Other researchers have attempted to document the issues female students will face as they choose to pursue science in tertiary schooling or as careers (Quinn & Cooc, 2015; Xu, 2015). With the current body of literature focused on aptitude differences and interventions promoting continued female student engagement, the root of the problem has not adequately been addressed. Furthermore, attitude differences between male and female students should be explored in greater depth as a child's attitude is complex and multidimensional (Hillman et al., 2016). The problem is the need for a clearer understanding of current middle school students' attitudes toward science across specific attitude domains to determine whether a gender gap still exists in each of these areas in schools today (Beyer, 2014; Braund & Reiss, 2006; George, 2006; Lee et al., 2016; Naizer et al., 2014).

Purpose Statement

The purpose of this quantitative study is to compare male and female students' attitudes toward science using a causal comparative research design. The independent variable is the biological sex of the students. The dependent variables are the four domains of student attitudes toward science defined by Hillman, Zeeman, Tilburg, and List (2016). They are attitudes toward school science, desire to become a scientist, value of science to society, and perceptions of scientists. The phrase *attitudes toward science* is used frequently in publications on the topic but is defined by Osborne et al. (2003) as "the feelings, beliefs, and values held about an object that may be the enterprise of science, school science, the impact of science on society, or scientists themselves" (p. 1053). The attitudes of sixth, seventh, and eighth grade male and female students will be compared using the My Attitudes Toward Science (MATS) instrument (Hillman et al., 2016). Each of the four domains of attitudes toward science defined by Hillman and colleagues comprises one subscale of the MATS instrument.

Significance of the Study

The economic performance of a country is clearly associated with the number of scientists and engineers created by its society (Osborne et al., 2003). Improving students' attitudes toward science is just as vital to the recruitment of future scientists as is the improvement of their scientific aptitudes. Though research on differences in students' attitudes toward science based on biological sex has been done in the past, most literature focuses on differences in achievement or aptitude of male and female students rather than differences in attitude. Furthermore, it is not enough to document that an overall difference exists in the attitudes held by male and female students; instead, it is important to understand the more specific domains that shape the attitudes held by these students toward science. The students' attitudes toward school science, desire to become scientists, value of science to society, and perceptions of scientists contribute to students' overall attitudes toward science (Hillman et al., 2014). Examining these differences at the middle school level will help educators identify and remediate problems early to ensure students maintain positive attitudes toward science through secondary and tertiary levels of schooling with the ultimate goal of filling roles in science professions.

Students need learning experiences embedded within their science curricula that will allow them to view themselves as future scientists or scientifically literate citizens (Murcia, 2013). According to Murcia (2013), "consideration has to be given to learning and teaching practices that show potential to transform not only students' knowledge, but their attitudes and beliefs about science and technology" (p. 20). Understanding how students view themselves and their ability to become future scientists will provide insight for educators and curriculum writers to alter science courses to reach a majority of students in this goal.

Kennedy et al. (2014) found fewer students have been choosing to enroll in elective science courses in high school, and enrollment continues to decrease. They suggest continued monitoring of the trends in science course enrollment (Kennedy et al., 2014). These trends can be evaluated in relation to biological sex of students (Kennedy et al., 2014). Wang and Degol (2017) recommend further examination of the interplay of factors influencing female science, technology, engineering, and mathematics (STEM) career choices. This dissertation will examine four specific domains of students' attitudes toward science and provide continued monitoring of the gender gap in science at the middle school level.

This study will further the current understanding of the gender gap in science by examining differences in specific attitudes toward science of male and female students. The study will examine differences between male and female students' attitudes in terms of their attitudes toward school science, desire to become scientists, value of science to society, or perceptions of scientists. Each of these attitude domains is to be assessed using the new My Attitudes Toward Science (MATS) instrument. As student attitudes may directly affect future scientific endeavors, this study will make a contribution to current literature by demonstrating how male and female middle school students' attitudes toward science compare when examined across these specific domains. The theoretical significance of the study is the continued contribution of knowledge regarding differences in science attitudes based on biological sex. The practical implications will allow middle school educators to understand how positively or negatively current middle school students view school science, science as a career, its value to society, and scientist stereotypes.

Research Question

RQ1: To what extent do attitudes toward school science, desire to become a scientist, value of science to society, and perceptions of scientists of male and female middle school students differ as measured by the My Attitudes Toward Science instrument?

Definitions

Attitude toward science – "The feelings, beliefs and values held about an object that may be the enterprise of science, school science, the impact of science on society, or scientists themselves" (Osborne et al., 2003, p. 1053).

Attitude toward school science – "how students felt about the subject of science" (Hillman et al., 2016, p. 207).

Value – "Students' attitudes toward the discoveries and technological advances that occur through STEM" (Hillman et al., 2016, p. 207). Value in this study is a student's perception of the benefits science practices provide for society.

Desire – "Interest in a scientific career" (Hillman et al., 2016, p. 207).

Perception – Stereotypical ideation of scientists (Hillman et al., 2016).

Interest – The combination of attaining a knowledge base in science, the perceived value of science, and the enjoyment of learning science (Ainley & Ainley, 2011).

Motivation – The drive that directs student learning (Lee et al., 2016).

Inquiry – The use of knowledge, reasoning, and skills to conduct investigations in a manner similar to the process used by scientists (Lakin & Wallace, 2015).

CHAPTER TWO: LITERATURE REVIEW

Overview

This chapter will provide an overview of the theories relating to students' attitudes toward science. A review of the literature will follow providing a foundation for each dependent variable of the present study. Male and female students' attitudes toward school science, desire to become scientists, value of science to society, and perceptions of scientists will be explored. The review of literature will discuss the theoretical overview and examine related literature.

Theoretical Framework

This dissertation will explore differences in attitudes toward science of male and female middle school students. The theoretical framework for this dissertation utilizes expectancy-value theory to explore reasons for students' attitudes toward science. Gender theories will be used to explore differences in these attitudes based on biological sex.

Expectancy-Value Theory

According to George (2006), "the development of positive attitudes toward science can motivate student interest in science education and science-related careers" (p. 571). A student's attitude toward science will ultimately determine how the student participates in science activities as well as his or her choice to pursue additional science coursework and science-related careers. According to Brown, Smith, Thoman, Allen, and Muragishi (2015), careers and educational choices depend on how well students expect they will do in a given field and how valuable the field is to them. The student's choice to participate in science, persistence in science, and performance can be explained by the expectancy-value model of achievement and performance (Wigfield & Eccles, 2000).

In expectancy-value theory (EVT), expectancy is defined as the student's belief about his or her ability to perform well on a given task (Wigfield & Eccles, 2000). This belief is determined by the student's perceived competence (Wigfield & Eccles, 2000). Current competence of a student would predict the expectation for success (Wigfield & Eccles, 2000). In the case of science attitudes, students who perceive they are competent in the subject will have more positive attitudes toward science and will therefore be more willing to participate in future science-related activities.

In EVT, value is defined to have four components: "attainment value or importance, intrinsic value, utility value or usefulness of the task, and cost" (Wigfield & Eccles, 2000, p. 72). The attainment value refers to the importance of achievement while intrinsic value refers to enjoyment (Wigfield & Eccles, 2000). Utility value is defined as the usefulness of the task to the student's future (Wigfield & Eccles, 2000). Students may consider science courses useful for extrinsic reasons such as admittance to college (Wigfield & Eccles, 2000). Cost refers to the emotional, physical, or financial commitment required by the task (Wigfield & Eccles, 2000). A science course may cost students time due to studying or a financial payment in the form of tuition. The combined task value has shown to strongly predict students' intentions to take future courses in a given field (Wigfield & Eccles, 2000).

Utility values can be broken down further into two categories: other-focused and self-focused (Brown, Smith, Thoman, Allen, & Muragishi, 2015). Other-focused utility values refer to tasks that are useful to other people such as medicine or recycling (Brown et al., 2015). Other-focused utility values involve working with other people, forming bonds, or performing tasks that will benefit society (Brown et al., 2015). Self-focused utility values are the tasks that are useful in the students' daily lives such as cell phone use or video games (Brown et al., 2015).

Self-focused values involve agency which is associated with new experiences, acquisition of power, and achievement (Brown et al., 2015). Other-focused and self-focused values operate independent of one another and will vary based on the activity (Brown et al., 2015).

As students get older, their expectations for success along with their value of selected activities decrease (Wigfield & Eccles, 2000). Students in early adolescence are more capable of accurately evaluating their own abilities and limitations (Wang, Chow, Degol, & Eccles, 2017; Wigfield & Eccles, 2000). They are able to compare their work to that of their peers (Wang et al., 2017; Wigfield & Eccles, 2000). With this greater understanding of their abilities, older students believe they are less competent which results in more negative expectancy views (Wigfield & Eccles, 2000). Expectancy and value beliefs also continue to be shaped by society as children get older (Brown et al., 2015). Students' observations of societal norms, such as the people that typically occupy certain social roles, may alter what students expect of themselves (Brown et al., 2015).

Students' motivation for science can be demonstrated by positive attitudes toward science across various domains: school science, desire to become a scientist, value of science to society, and perception of scientists (Hillman et al., 2016). EVT offers an explanation for students' motivation in each of these domains as well as a connection among them. Students perceiving they have a greater competence in school science, for example, may be more motivated to become scientists. Students will also be more motivated to pursue science based on positive perceived values of science.

Gender Theories

Gender theories will build upon expectancy-value theory in this theoretical framework by extending explanations for differences in students' expectancy values based on biological sex.

What male and female students perceive as acceptable, or even expected, for their biological sex will in turn dictate what they expect of themselves. As students become increasingly aware of social norms, their views of themselves will continue to change (Brown et al., 2015).

Biological. Students' expectations for their own achievement and their perceived social role can be explained, in part, by biological factors. Men and women within a society often occupy different societal roles because of physical differences between sexes. Biosocial constructionist theory (2002) states that the division of labor between sexes stems from these physical differences (Eagly & Wood, 2013). This theory was developed by Wood and Eagly in response to the nature vs. nurture debate in psychology (Eagly & Wood, 2013). Though many psychologists attempted to explain differences in men and women through social theories prior to the 1980s, later research suggested biological differences were responsible (Eagly & Wood, 2013). Eagly and Wood (2013) used the biosocial constructionist theory to meld the viewpoints together into an interaction perspective rather than either a strict nature or nurture perspective. According to this theory, "biological difference emerges in human societies as a division of labor as the effects of male and female biology are moderated by the social environment" (Eagly & Wood, 2013, p. 350). Differences are first caused by biological variations in males and females (Eagly & Wood, 2013). Men are physically built to be larger and stronger than women (Eagly & Wood, 2013). Due to the biological responsibility of motherhood, women act as caregivers and retain an innate desire to nurture and build relationships (Eagly & Wood, 2013). The physical differences that exist in men and women may contribute to a division in labor with some jobs being potentially better suited to one sex over the other (Eagly & Wood, 2013).

Evolutionary psychologists extend biosocial constructionist theory to explain the tendencies that attract males and females to different careers. Males evolved with the desire to gain resources in order to attract mates (Eagly & Wood, 1999). Today, these tendencies are realized as men compete for careers that offer power and money (Eagly & Wood, 1999). The biological urge for men to acquire resources pushes them into careers that allow for advancement and autonomy (Eagly & Wood, 1999). Many science professions are associated with prestige and money attracting men to the field (Eagly & Wood, 1999). Women do not compete for such positions as readily as men, however, because of their perceptions of barriers to career advancement based on biological sex (Watts, Frame, Moffett, Van Hein, & Hein, 2015). Women anticipate more "sex discrimination and conflict between children and career demands" than men (Watts et al., 2015, p. 18). Ng, Kuron, Lyons, and Schweitzer (2011) found that pre-career women "adjust[ed] their salary expectations downward in exchange for greater work/life balance" (pp. 435-436).

Social. The division in labor based on biological sex may have first been generated through biological factors but is perpetuated in modern society through social factors (Eagly & Wood, 2013). As students observe the differences in social roles filled by adults of previous generations, their own expectations are affected (Brown et al., 2015). Martin and Halverson's gender schema theory (1981) posits that males and females categorize roles, behaviors, and interests into gender schemas based on environmental information (Weisgram & Bigler, 2006). Males and females then determine which schema is to include their own behaviors and interests, "categorizing information as 'for me' or 'not for me' based on their sex" (Weisgram & Bigler, 2006, p. 329). Gender schema theory indicates that science is considered a male domain based on environmental information which suggests males will demonstrate more positive attitudes toward science.

Similar to gender schema theory, Eagly's social role theory (1987) indicates that students develop stereotypical perspectives of male and female roles based on their observations of older males and females actually participating in those roles (Miller, Eagly, & Linn, 2015; Eagly & Karau, 2002). Social role theory depends on two major expectations for the perceiver: "descriptive norms, which are consensual expectations about what members of a group actually do, and injunctive norms, which are consensual expectations about what a group of people ought to do or ideally would do" (Eagly & Karau, 2002, p. 574). Descriptive norms are the stereotypes associated with a group of people based on actual behavior, but gender roles rely additionally on those attributes society considers desirable in either males or females (Eagly & Karau, 2002). Therefore, gender roles are created through the combination of descriptive norms and injunctive norms (Eagly & Karau, 2002). According to gender stereotypes, males are considered agentic, demonstrating characteristics such as assertiveness, controlling behavior, confidence, aggression, ambition, dominance, and independence (Eagly & Karau, 2002). These traits make males "prone to act as a leader" (Eagly & Karau, 2002, p. 574). Females are described as communal and considered primarily concerned "with the welfare of other people—for example, affectionate, helpful, kind, sympathetic, interpersonally sensitive, nurturant, and gentle" (Eagly & Karau, 2002, p. 574).

Liben and Bigler (2006) developed an attitudinal pathway model (2002) to demonstrate the way students' attitudes are shaped by more than just gender schemas. The attitudinal pathway model begins with students' endorsement of gender stereotypes (Weisgram & Bigler, 2006). Students who endorse gender stereotypes will not consider participating in activities aligned with the opposite sex (Weisgram & Bigler, 2006). These decisions are made before the students even consider how interested they could have been in such activities (Weisgram &

Bigler, 2006). Those who do not endorse gender stereotypes, however, will investigate the field further to determine their personal levels of interest (Weisgram & Bigler, 2006).

As students' stereotypical perceptions are formed, they begin to behave in ways that are congruent with what is expected for their biological sex. Role congruity theory (2002) was developed by Eagly and Karau. It is grounded in Eagly's social role theory but extends the theory by considering the congruity between gender roles and other roles in society (Eagly & Karau, 2002). Role congruity theory suggests that males and females conforming to stereotypical expectations are rewarded in society (Stout, Grunberg, & Ito, 2016). Males and females choosing roles congruent with societal expectations feel more positive with their choices (Stout et al., 2016). Males or females occupying non-stereotypical roles, in contrast, are sometimes met with disapproval (Eagly & Karau, 2002). For example, leadership positions are associated with agentic attributes more consistent with the masculine stereotype. Females are less likely to secure leadership positions because the desirable attributes for leadership roles diverge so widely from desirable attributes of females in general (Eagly & Karau, 2002). When females are successful in leadership roles, however, they are sometimes thought to "violate standards for their gender when they manifest male-stereotypical, agentic attributes and fail to manifest female-stereotypical, communal attributes" (Eagly & Karau, 2002, p. 575). Those who endorse traditional gender roles will view these violations unfavorably (Eagly & Karau, 2002). Role congruity theory posits that males should occupy positions aligned with agency while females should occupy positions aligned with affiliation (Stout et al., 2016). Those who endorse gender stereotypes would then believe that males are better suited for careers in science than females. Additionally, differences exist in the careers held by males and females within science. Males are more likely to hold positions in physical sciences, technology, and engineering that allow for autonomy and advancement (Stout et al., 2016). Females are more likely to hold positions in biological sciences that offer opportunities to feel communal (Stout et al., 2016).

Social Cognitive Theory

In science, male and female students also differ in their expectations for success. Bandura's social cognitive theory (1997) relies on the mechanism of self-efficacy to explain students' expectancies for success (Ross, Scott, & Bruce, 2012). Self-efficacy is the student's belief in his or her ability to perform a task (Ross et al., 2012). Greater self-efficacy indicates a greater expectancy for achievement on the task (Ross et al., 2012). Improved self-efficacy leads to increased confidence levels and more positive attitudes toward the task (Ross et al., 2012). As gender theories demonstrate, students use environmental information to determine that science is a male domain (Eagly & Karau, 2002; Eagly & Wood, 2013; Weisgram & Bigler, 2006). Male students will develop greater self-efficacy due to this belief while female students will experience decreased self-efficacy with endorsement of stereotypical gender roles. The female students will therefore not have high expectancy values for success in science. A loss in confidence experienced by female students translates to more negative attitudes toward science overall (Ross et al., 2012).

Theory of Circumscription and Compromise

According to Gottfredson's (1981) theory of circumscription and compromise, the choice of careers begins in childhood and progresses through a series of eliminations as children get older (Cochran, Wang, Stevenson, Johnson, & Crews, 2011). Children begin to determine which careers are most suitable for themselves based on their self-concepts (Cochran et al., 2011). This means different things for children in different age groups. Initially, young children between three and five years of age eliminate choices for their futures based on what is realistic for people in a society (Cochran et al., 2011). This is the age group of children that will learn they cannot grow up to be fictional characters or animals (Cochran et al., 2011).

As the children grow, they will pay additional attention to the adults around them. Children six to eight years of age may become aware of gender stereotypes and begin to align their own identities with occupational aspirations that will be considered socially acceptable based on their biological sex (Cochran et al., 2011). Children between the ages of nine and 13 also become aware of differences in socioeconomic status and begin to realize that some jobs are related to greater prestige, salaries, and status in society (Cochran et al., 2011). Children in this age group begin to navigate what status level they hope to achieve while considering what they consider to be realistic based on their current circumstances (Cochran et al., 2011). Finally, children 14 and above consider their own personality traits, interests, values, and the work-life balance they hope to achieve in adulthood allowing them to further eliminate career choices (Cochran et al., 2011).

Based on this theory, female students may be disadvantaged in career selection beginning even in childhood. Children base their career choices on what they perceive to be congruent with their own identities which includes their biological sex (Cochran et al., 2011). The existence of sex stereotypes and gendered career patterns may influence the choices girls make in careers causing them to eliminate male-dominated professions without giving these professions proper consideration. Many young girls may exclude careers involving science, technology, engineering, or mathematics from their potential career options, believing these options do not coincide with their personal identities.

Conclusion

Students' attitudes toward science are heavily impacted by the students' perceptions of their own expectancy, value, and self-efficacy. Self-efficacy, as indicated in Bandura's (1997) social cognitive theory, contributes to students' expectations for success. Their belief in their own abilities increases their expectancy values. Students are also influenced by the value they ascribe to a given task. Gender theories offer explanations for differences that exist in students' attitudes based on biological sex. Differences that exist in male and female roles may be caused by biological variations that occur between sexes. These differences are perpetuated through observance and adherence to societal norms. Finally, the theory of circumscription and compromise helps explain differences in children's choice of careers based on biological sex.

Related Literature

Students' attitudes toward science have been studied for more than 40 years in educational research and continue to have significance in educational research today (Buck et al., 2014; Bybee & McCrae, 2011; Naizer et al., 2014; Osborne et al., 2003). The interest in students' attitudes toward science is important due to its "established relationships with achievement, course selection, career choice, and lifelong learning" (Bybee & McCrae, 2011, p. 14). It also affects the way students approach their coursework (Teodorescu, Bennhold, Feldman, & Medsker, 2014). Continued research into student attitudes can allow for continued improvement of science curricula resulting in higher retention of science students through secondary and tertiary levels of education and a greater number of graduates entering science professions.

Attitudes Toward School Science

Science attitudes are the integration of several attitude constructs (Hillman et al., 2016). Attitude toward school science is one of these constructs (Hillman et al., 2016). It was defined by Hillman, Zeeman, Tilburg, and List (2016) as the way "students felt about the subject of science" (p. 207). Attitudes toward school science refers to the students' willingness to participate in learning science and their enjoyment in learning school science. This attitude construct can be affected by several factors including the science content presented in the curriculum and the influence of biological sex of the students toward science.

The influence of curriculum on students' attitudes toward science. Middle school students often hold negative attitudes toward science because they fail to see its relevance in their daily lives (Lyons & Quinn, 2012). Current curricula are charged with the goal of educating future scientists rather than educating future citizens, which can lead to the majority of students viewing science curricula unfavorably (Bybee & McCrae, 2011; Quinn & Cooc, 2015). These curricula are content-oriented and place little emphasis on skill development (Teodorescu, et al., 2014). Current science courses lack "an adequate balance of theory and practice [so] that students see the relevance" (Baillie & Fitzgerald, 2000, p. 154).

The United States is attempting to find an adequate balance between theory and practice by introducing the Next Generation Science Standards (NGSS) in many states to better align science instruction to the science experienced in daily life (Guzey, Moore, Harwell, & Moreno, 2016; Lee et al., 2016). The newly developed science standard framework provides not only a body of knowledge to be learned but focuses on the skills needed to continually revise the body of knowledge through scientific endeavors (Guzey et al., 2016). Engineering practices are therefore embedded within the framework along with the major disciplines of science (Guzey et al., 2016). With these curricular changes, students may see the relevance of science in their daily lives which could improve their overall attitudes toward science.

Curricular reforms throughout the last two decades have pushed for the use of inquiry-based lessons in science classrooms (Wolf & Fraser, 2008). National education standards, such as those associated with No Child Left Behind (NCLB) or the 1996 National Science Education Standards, focus on the significance of hands-on and problem-solving activities (Baker & White, 2003; Wolf & Fraser, 2008). Problem-based learning (PBL) has shown to motivate students and increase their engagement in science classroom activities (Kanter & Konstantopoulos, 2010). Students lose interest in the subject when they are not active participants in the learning process (Ali, Yager, Hacieminoglu, & Caliskan, 2013). PBL units build on the pedagogical practice of inquiry by compelling the students to find a solution to a real-world problem (Baker & White, 2003; Buck et al., 2014). This method of instruction allows for “a dynamic space where power, authority, control, learning, and teaching are shifted between teacher and students” (Buck et al., 2014, p. 436).

The goal for improving a student’s attitude toward a subject such as science relies largely on the student’s ability to take ownership of the learning experience. Middle school students thrive on choices built into the curriculum (Gentry, Gable, & Springer, 2000). When teachers provide choices, they are allowing students to tailor their education to their strengths and interests (Gentry et al., 2000). Ultimately, this will cause students to be more motivated to learn and produce better quality projects (Gentry et al., 2000).

Science curricula may vary considerably among districts, schools, and even individual classrooms. School science, however, may not be the only driving factor in students’ attitudes toward science. Personal attitudes and interests of the students as individuals will impact students' views of science (Bybee & McCrae, 2011). Family beliefs and experiences may also play a large role in the way students approach school science (Lyons & Quinn, 2012). Students from lower socioeconomic backgrounds may not consider tertiary study a possibility (Lyons & Quinn, 2012). Science courses become increasingly academic through secondary school to prepare students for college-level science courses (Lyons & Quinn, 2012). Students uninterested in pursuing higher education degrees would then find these courses less enjoyable than the exploratory science classes experienced in childhood (Lyons & Quinn, 2012).

The influence of biological sex on students' attitudes toward science. Differences have been found in middle school students' attitudes toward science based on the biological sex of the students. Male students tend to have more positive attitudes toward science than female students. Additionally, male and female middle school students show preferences for different disciplines of science.

***Males*.** Male students are reported to have "a consistently more positive attitude [toward] school science than girls" (Chen & Howard, 2010, p. 138). Specifically, male students view technology use in the science classroom more favorably than female students (Incantalupo, Treagust, & Koul, 2014). Male students have a greater interest in "discovering new things" than female students (Chen & Howard, 2010, p. 138). They are willing to take the risks associated with conducting science (Eagly & Wood, 2013).

Male students' willingness to utilize technology and to take risks to discover new things can be attributed to the assertiveness and confidence that categorize many male students (Eagly & Wood, 2013; Ross et al., 2012). Assertiveness and confidence are associated with the masculine identity (Eagly & Wood, 2013). Male students displaying these characteristics have generally positive attitudes toward school science as it provides an outlet for their autonomy (Stout et al., 2016).

In addition to overall attitude differences between male and female students, the science topics preferred for study by each biological sex are also different (Bybee & McCrae, 2011; Jenkins & Nelson, 2005). In a study by Jenkins and Nelson (2005) on students' interest in science topics, male and female preferences differed significantly on more than 80 of the 108 total items. Males tend to show a preference for destructive events and technology (Bybee & McCrae, 2011; Jenkins & Nelson, 2005). Specific topics of interest to males include learning about how an atomic bomb operates, the use of lasers for technical purposes, and nuclear power generation (Jenkins & Nelson, 2005). They are more likely than females to use science for fixing things, building models, and seeking action-oriented activities (Wolf & Fraser, 2008). The science topics preferred by male students translate to specific science course preferences. Male students repeatedly show a clear preference for physical science and technology courses (Baram-Tsabari & Yarden, 2011; Beyer, 2014; Kennedy et al., 2014).

Experiences outside of school are partly responsible for the self-efficacy and confidence levels of male students in particular topics of scientific learning. Males often have more experience with electric toys and batteries (Jones et al., 2000; Wolf & Fraser, 2008). They typically spend more time on computers for personal use than females and are more likely to have experience installing computer hardware (Beyer, 2014; Lim & Meier, 2011). Male students utilize technology more than females because of the stereotypical socialization patterns experienced in childhood (Lim & Meier, 2011). Male students' dominance in computer use operates in a self-fulfilling prophecy where males are more confident with computers because their parents and larger society believe males are more skilled in their use (Lim & Meier, 2011).

Their confidence leads to more extensive computer use allowing them to become more skilled and further confident (Lim & Meier, 2011). These experiences may influence the way students feel about learning subjects related to technology in school (Jones et al., 2000; Wolf & Fraser, 2008).

Females. Female students are found to show less interest in science than their male counterparts (Smith et al., 2014). By middle school, there is a noticeable gap between males and females in science achievement and attitude which is even more dramatic by age 17 (Naizer et al., 2014). The decline in both achievement and attitude is speculated to come from a loss in student confidence (Naizer et al., 2014). According to Naizer et al. (2014), "many believe it is an age-related phenomenon associated with pubertal changes and cognitive maturation" (p. 29). A contradictory study by Shah, Mahood, and Harrison (2013) demonstrated an increase in female students' attitudes toward school science, however. This finding applied to Pakistani students and was speculated to have been related to Pakistani females' strong work ethic (Shah, Mahood, & Harrison, 2013). Their study focused on the students' preferences for activities such as homework, class activities, discussions with teachers, and studying which is not always stressed in other science attitude studies (Shah et al., 2013). Most researchers focusing on the subject of science, rather than the type of schoolwork it entails, suggest female students have more negative attitudes toward the subject of science than male students (Buck et al., 2014; Machina & Gokhale, 2009; Naizer et al., 2014).

Confidence differences between male and female students can lead to differences in attitudes toward school science. Social cognitive learning theory suggests female students are less likely to demonstrate positive attitudes toward school science because they do not perceive science as a female domain (Ross et al., 2012). This belief stems from female students observing male dominance in STEM fields which in turn causes anxiety for learning such subjects in school (Ross et al., 2012). Female students lose confidence in their own abilities and are less willing to engage in science in school (Ross et al., 2012). Female students feel a similar anxiety with technology believing it is a male domain (Lim & Meier, 2011). Their lack of confidence affects female students to the extent that they believe negative experiences with computers are due to their own ineptitude while male students contribute similar negative experiences to technological deficiencies (Lim & Meier, 2011).

Cady and Terrell (2008) suggest girls begin to experience feelings of inadequacy at a young age, especially when it comes to technology in the science classroom. These feelings could be prevented if female students would be granted more opportunities to become familiar with and experienced in the use of technology (Cady & Terrell, 2008). Many girls have difficulty identifying with characters presented in educational software (Incantalupo et al., 2014). Confidence differences between male and female students are already apparent in fourth grade and widen by the eighth grade (Smith et al., 2014). The disparity in confidence leads to a difference in students "liking" science where fewer female students enjoy the subject by eighth grade (Smith et al., 2014). When teachers make a conscious effort to utilize different forms of technology in the science classroom, they provide the practice required to raise students' self-efficacy (Cady & Terrell, 2008). Increased use of technology, especially when coupled with inquiry-based units, has shown to improve female students' attitudes toward science and technology (Baker & White, 2003).

To minimize the number of female students lost in science and technology career fields, educational researchers and school officials have piloted numerous programs to improve female students' attitudes (Buck et al., 2014; Machina & Gokhale, 2009; Naizer et al., 2014). Attitudes toward science have improved for female students involved in these programs. Female students benefited from a summer engineering program that allowed female students to work alongside undergraduate students and faculty members of a nearby college (Naizer et al., 2014). In another intervention, researchers, educators, and a local university worked together to develop problem-based units that could be implemented by classroom teachers (Buck et al., 2014). Funding through the university provided for a true laboratory classroom with a trained STEM teacher, lab coats, and laboratory books and supplies (Buck et al., 2014). The program effectively increased female student interest and efficacy in science (Buck et al., 2014). Buck et al. (2014) explain that female students' attitudes toward science improved for several reasons including their supportive relationship achieved with the laboratory teacher, the opportunity for more authentic learning during problem-based units, and an increased utility value perceived by the students. The students were able to view science "as something that they would need to advance in their schooling, as well as something that they need for their future" (Buck et al., 2014, p. 449). A similar study by Machina and Gokhale (2009) demonstrated the importance of providing female students with opportunities to meet and work with science and technology professionals.

Problem-based learning (PBL) has shown to improve achievement and self-efficacy for female students suggesting these lessons are more effective than traditional lessons but may require additional support for female students (Desy et al., 2011; Farland-Smith, 2009; Wolf & Fraser, 2008). Having the ability to design their own investigations encourages enthusiasm from female students (Buck et al., 2014; Farland-Smith, 2009). When PBL lessons are used, however, teachers must also be cognizant of female students' confidence levels. Wolf and Fraser (2008) found that many female students were concerned with the correctness with which they designed their experiments. Some of these students were also frustrated by the open nature of these lessons showing a clear preference for activities that are designed and clearly explained by the teacher (Wolf & Fraser, 2008).

Bottia, Stearns, Mickelson, Moller, and Valentino (2015) demonstrated the importance of female teachers in science and math classes serving as role models for female students to pursue and obtain STEM degrees. Similarly, Stearns et al. (2016) found a higher percentage of female students decided to major in science in college from high schools with higher proportions of female math and science teachers. The greater percentage of female STEM teachers did not decrease the rate of male students choosing to pursue science, however, suggesting it is beneficial to increase the number of females teaching high school math and science courses (Stearns et al., 2016). Female students benefit from the support of their teachers which helps them stay engaged in science (Tan, Calabrese Barton, Kang, & O'Neill, 2013). This need for teacher support is the same for all female students regardless of their class averages in science courses (Tan et al., 2013). Aside from providing sustained access to female science teachers, it is important for schools to introduce competent science teachers as early as possible. Even elementary school students are positively affected by experiences with scientifically-trained teachers (Buck et al., 2014).

Female science teachers can play an even more significant role as role models for female students by promoting supportive work environments within the classroom (Hong & Lin, 2011). Female students need to feel safe to explore without the fear of being wrong. Science teachers can also encourage female students by providing compliments and positive reinforcement for their work in science (Buck et al., 2014). Engaging in dialogue with female students about future career plans and the possibilities of science professions will help promote student perceptions (Buck et al., 2014). The position of teachers as role models has been found to be so important to female students that their influence is often more significant than the support received from parents (Desy et al., 2011).

Support from parents and peers can contribute significantly to a female student's willingness to enter science fields (Ing, 2014; Gokhale et al., 2015; Ochsenfeld, 2016). Specifically, parental support was shown to significantly increase the likelihood of female students continuing in science from seventh through twelfth grade (Ing, 2014). Though female students want to be supported by their parents, Ochsenfeld (2016) has found that it is more important to these students to choose programs of study in college that will receive approval from their peers. Peer approval had a more significant impact on female students' decisions than parental approval (Ochsenfeld, 2016). Approval from male peers has been found to be even more significant for female students as they take increasingly more technical courses from their freshman to senior years (Gokhale et al., 2015).

In addition to the differences in attitudes of male and female students toward science overall, differences can be found in students' preferences for science subjects based on biological sex. Female students tend to most enjoy science topics relating to health, mind, and wellbeing (Beyer, 2014; Bybee & McCrae, 2011; Desy et al., 2011; Jenkins & Nelson, 2005). This may be due to the relevance perceived by survey participants where health technologies, such as ultrasounds, could be applicable to female students' lives as they grow older (Bybee & McCrae, 2011). Female students show a preference over male students for learning about topics such as cosmetic surgery, the growth and maturation of babies, and alternative therapies (Jenkins & Nelson, 2005). Females tend to seek out biological activities such as gardening or caring for animals (Jones et al., 2000; Wolf & Fraser, 2008). They are also more interested in learning about the existence of witches and ghosts, the meaning of dreams, and the human soul (Jenkins

& Nelson, 2005). Overall, female students are more drawn to sciences that are meant to help others (Jones et al., 2000). Therefore, female students are more interested in biological sciences in school, though Earth science courses have also started becoming more popular among female students (Baram-Tsabari & Yarden, 2011; Kennedy et al., 2014). Subjects female students prefer over traditional science courses include nursing, psychology, and English (Beyer, 2014).

The subjects that female students prefer align with the female tendency to nurture (Eagly & Wood, 2013). Female students may prefer biological sciences over other science disciplines because it provides them with the opportunity to help others (Beyer, 2014). The desire to help others is derived from a combination of biological and social factors. Oxytocin operating within the female body generates nurturing tendencies which are further developed through neurochemical processes (Eagly, 2009). Mothers spend a greater amount of time talking to their infant daughters than to their infant sons perpetuating differences in nurturing tendencies (Eckes & Trautner, 2000).

Conclusion. Male and female students differ in their attitudes toward school science at the middle school level. Male students show more positive attitudes toward science courses than female students. Male students also show greater confidence in and affinity for physical sciences and technological courses than female students.

Desire to Become a Scientist

A middle school student's desire to become a scientist is based on his or her interest in pursuing any career in a scientific, medical or technological discipline (Hillman et al., 2016). In science education research, interest can be defined as the combination of learning science, the enjoyment students experience while learning science, and their perceived value of science (Ainley & Ainley, 2011). Value perceived by students is the extent to which the students believe science is worthwhile (Tighezza, 2014). It is derived from a combination of intrinsic and extrinsic factors such as the enjoyment a student will experience from learning the subject, the identity formed by the student in the process, and the personal, social, and financial cost associated with learning the subject (Tighezza, 2014). According to Ainley and Ainley (2011), students showing an interest in science will actively seek out opportunities to engage in science activities in the future. Middle school students in the United States are losing interest in science (Beyer, 2014; Braund & Reiss, 2006; George, 2006; Lee et al., 2016; Naizer et al., 2014). With reduced interest in science, current middle school students may not actively engage in science activities, such as electing to take additional science courses, which could ultimately lead to scientific careers.

In a study by Jenkins and Nelson (2005), students indicated their interest in potential careers in science through a questionnaire. The study focused on 14- and 15-year old students in England (Jenkins & Nelson, 2005). Based on student responses, it was apparent to the researchers that “many young people have already made up their minds whether or not they wish to pursue a career in science or technology” by the time they reach the ages of 14 and 15 (Jenkins & Nelson, 2005, p. 53). Students are already considering their choice of careers during their middle school years suggesting it is particularly important to develop high-quality science education in these grades (Jenkins & Nelson, 2005). Jenkins and Nelson (2005) suggest two reasons to explain why 14- and 15-year old students are unlikely to desire careers in science. One reason is that students in the middle school have only a vague understanding of what science-related careers exist and what these careers actually entail (Jenkins & Nelson, 2005). Students in the middle school are also less likely to consider science-related careers because they lose motivation for learning science in school (Jenkins & Nelson, 2005).

The loss of motivation for learning science is rooted in two changes experienced by middle school students. One main cause for motivational decline is the maturation of the brain (Wang et al., 2017). In elementary school, students are overly optimistic and lack a realistic view of their abilities (Wang et al., 2017; Wigfield & Eccles, 2000). By middle school, the students have matured to the point that they compare their performance to the performance of their peers, developing a more realistic understanding of their own capabilities and limitations (Wang et al., 2017; Wigfield & Eccles, 2000). Based on their new self-perceptions, "many youth may begin to lower their perceived competence in science, leading to declines in their interest and desire to pursue a science career" (Wang et al., 2017, p. 1822). Motivational decline is also linked to the disparity created at the middle school level between the needs of adolescent students and the environment of the middle school (Wang et al., 2017). Middle schools become more controlling at a time when the students desire greater autonomy which stifles their motivation for school work (Wang et al., 2017).

Males' desire to become a scientist. Many fields of science, such as the physical sciences, engineering, and technology, are persistently male-dominated (Desy et al., 2011; Stout et al., 2016). Preferences for these subjects begin in middle school or earlier (Desy et al., 2011; Jenkins & Nelson, 2005). Middle school males are significantly more likely to express a desire for a career in technology, engineering, or mathematics than middle school females (Desy et al., 2011; Jenkins & Nelson, 2005). These disciplines within science are in contrast to behavioral, social, medical, and biological sciences. The stereotypes associated with physical sciences, engineering, and technology portray these disciplines to be isolating (Stout et al., 2016). These disciplines are considered to focus on inorganic objects rather than people (Stout et al., 2016).

Men are attracted to careers in the physical sciences due to their preferences for careers congruent with agency or self-promotion (Stout et al., 2016). Agency is also associated with "assertiveness, dominance, and confidence" allowing men to take greater risks than women (Eagly & Wood, 2013, p. 343). Historically, men have held leadership positions associated with power, money, and prestige (Stout et al., 2016). Men continue to be attracted into career fields that are expected to provide money and power (Stout et al., 2016; Weisgram & Bigler, 2006). Role congruity theory indicates that people continue to fill the roles typically expected for their gender by their society, and they are rewarded for their conformity (Stout et al., 2016). Therefore, men continue to pursue career fields that are better aligned with advancement and autonomy (Stout et al., 2016).

Evolutionary psychologists explain that males are attracted to careers that offer prestige and money because of the environmental conditions during which primeval humans' tendencies evolved (Eagly & Wood, 1999). Early women preferred mates who could provide resources for their offspring (Eagly & Wood, 1999). Men evolved the tendencies to "acquire more resources than other men in order to attract women" (Eagly & Wood, 1999, p. 411). These deep-rooted tendencies continue today as men seek jobs with greater prestige over other men and higher salaries to provide for their families (Eagly & Wood, 1999). Women today continue to demonstrate these tendencies when they are attracted to "successful, ambitious men" (Eagly & Wood, 1999, p. 411).

Interestingly, males valuing altruism and family are also more likely to show interest in science careers while females valuing altruism and family are unlikely to choose careers in science (Weisgram & Bigler, 2006). This difference may be due to what is perceived as acceptable gender roles. It is expected that females are the nurturers (Eagly & Wood, 1999, 2013). For males with greater altruistic interests, finding a career in medicine or pharmacy satisfies both the desire to help others and the need to keep within a career field that is considered acceptable for males within their culture (Weisgram & Bigler, 2006).

Females' desire to become a scientist. Overall, women are disproportionately underrepresented in current scientific and technological career fields (Cady & Terrell, 2008; Else-Quest et al., 2013; Oh & Lewis, 2011). The lack of women in science has been studied by numerous researchers over time, but no conclusive reason for the gender gap has been found. Each researcher has drawn conclusions about the imbalance of women in science, but the real reason is most likely a combination of the factors studied and may vary from woman to woman.

The lack of women in scientific careers has led to an inequality in earning potential across the United States (Oh & Lewis, 2011; Xu, 2015). Women in scientific careers earn more than women in other professions, though current studies have not been able to explain why this occurs (Naizer et al., 2014; Oh & Lewis, 2011). Researchers speculate that it could be due to these women having better mathematical skills than other women or that these women are more willing to work in male-dominated professions than other women (Oh & Lewis, 2011).

The underrepresentation of women does not occur across all science, technology, engineering, and mathematics (STEM) disciplines. In some science disciplines, such as veterinary medicine, female students actually outnumber male students (Jones et al., 2000). Between the years 2012 and 2017, women earned 48% of all medical doctor degrees and 54% of all biological science doctorates (Wang & Degol, 2017). Computer sciences and engineering fields have the lowest representation of women with women earning only 19% and 23% of degrees in these fields, respectively (Wang & Degol, 2017). Similarly, technology, physical sciences, mathematics, and statistics continue to have lower representations of women with only about one-third of degrees in these fields being earned by women each year (Wang & Degol, 2017). Desy et al. (2011) found that female middle school students showed a great interest in scientific careers. Consistent with current trends, four out of five of the most popular career choices cited by the female middle school students were in healthcare professions (Desy et al., 2011). These choices are in line with females' altruistic and communal tendencies. Healthcare professions allow females to help others which satisfies their innate desire to nurture (Eagly & Karau, 2002).

Though the gender gap appears to have vanished in some scientific fields, it is still very apparent in others. Wang and Degol (2017) speculate the difference may be due, in part, to how math-intensive technological and physical science fields can be. When individuals experience cognitive strengths in one domain, such as mathematics, they are more likely to pursue careers reliant upon their strengths to improve their potential for success (Wang & Degol, 2017). On the other hand, individuals with similar cognitive strengths in both mathematical and verbal domains have a broader spectrum of career options allowing these individuals to choose careers based on interest rather than ability (Wang & Degol, 2017). Women tend to fall into the latter category experiencing a greater equity in cognitive abilities across subject domains (Wang & Degol, 2017). Therefore, women base career decisions on other interests and values regardless of the talent they could possess in math (Wang & Degol, 2017).

Women are also lacking in STEM disciplines due to the desire to lead more balanced lives (Beyer, 2014). Women are less likely than men to prefer the work-centered lives necessary in many scientific career fields (Wang & Degol, 2017). Even women interested in science careers may not pursue them because their optimal years of fertility coincide with tenure pursuits (Wang & Degol, 2017). Though progress was made through feminist movements, American social norms continue to dictate that women are primarily responsible for caring for the children and the home (Wang & Degol, 2017). Women working to care for their families find it difficult to "allocate the time necessary to keep up with the latest innovations and remain competitive within the field" (Wang & Degol, 2017, p. 126).

Women value socialization more than men, dissuading them from choosing a career that is often thought to be more independent (Beyer, 2014). Beyer (2014) found young women valued "the opportunity to interact with people rather than things, opportunities to be helpful to others or society, and the ability to combine career and family" (p. 167). These desires stem from both biological and social factors. The female body relies upon oxytocin to promote maternal bonds and nurturing affiliations with others (Eagly, 2009). Neurochemical processes replace hormonal influence to the extent that females associate building relationships with reward (Eagly, 2009). Social contexts extend the effect produced by biological processes. Both parents perpetuate the gender role expected for their daughters through the expectations they hold for household chores and play which are different from the parents' expectations for their sons (Eckes & Trautner, 2000; Eagly & Wood, 2013). Women may, therefore, be less likely to work in fields that may be considered isolating (Beyer, 2014). Computer science, for example, is considered a field where people sit independently behind computers preventing them from the social aspects of the workplace (Beyer, 2014). Believing this stereotype keeps many women from entering this type of career field. Because females favor altruism and family, they instead opt for careers in fields such as child care or social work rather than many scientific disciplines (Weisgram & Bigler, 2006).

The desire for women to care for their families and to nurture relationships with others can be explained by biosocial constructionist theory (Eagly & Wood, 2013). According to this theory, the male-female division of labor originated through biological differences between biological sexes (Eagly & Wood, 2013). Males are physically larger and stronger than females, and females bear children (Eagly & Wood, 2013). The physical differences cause some activities to be performed more efficiently by one sex over the other (Eagly & Wood, 2013). Division of labor is perpetuated in society through the construction of gender roles; people generally approve of a specific set of activities to be performed by each sex (Eagly & Wood, 2013). Adolescents may conform to the identities associated with their prescribed gender roles (Eagly & Wood, 2013). Therefore, females may place a higher value on creating a family than developing a career.

For women who do persist in science, maternal responsibilities will reduce their earning potential in comparison to men (Xu, 2015). Though both men and women can become parents, the pregnancy, delivery, and lactation responsibilities of infants belong to women alone. A major inequity in earning potential based on biological sex was documented by Xu (2015) over a course of 10 years. During this time, women would work intermittently while taking time off for family obligations. The longitudinal data demonstrated that women were often penalized for family responsibilities (Xu, 2015). Similarly, Loison et al. (2017) demonstrated that marital and parental status contributed to career trajectories of scientific researchers where women with children advanced in their careers far less than single women, women with spouses also in research, and men. Women in university settings were also found to take on greater teaching loads leading to lower scientific productivity most likely for the benefit of having predictable work schedules that allow for time at home with their children (Loison et al., 2017).

Female students' attitudes toward careers in science have been affected positively by intervention programs. Having the ability to work alongside scientists during science programs is very beneficial in improving female students' attitudes toward science (Farland-Smith, 2009). Female middle school students who participated in the Side-by-Side program worked with different scientists each day, rotating through various fields of science such as chemistry, physics, biology, and geology (Farland-Smith, 2009). Though the students were already interested in science upon enrolling in the program, they made gains in their attitudes toward the individual fields of science (Farland-Smith, 2009). The students also gained a more accurate perspective about what scientists do creating more interest in the pursuit of scientific careers (Farland-Smith, 2009). They were able to gain a better understanding of the work of female scientists, allowing the students to visualize themselves in similar roles (Farland-Smith, 2009).

Many female students explicitly state that they disliked science in school but are choosing to pursue professions such as doctor or nurse (Desy et al., 2011). These students may choose careers in healthcare while believing they dislike science because they do not consider such careers to be careers in science (Desy et al., 2011). Another possible explanation for the disparity between the attitudes toward school science and the desire to become a scientist for these students is the perception of the word *science* (Desy et al., 2011). Many students associate the word science with physical science courses such as physics and chemistry that some female students dislike because of their extensive math and technical vocabulary content (Desy et al., 2011). The female students fail to realize they are choosing scientific careers when their career paths are outside of physical science.

Conclusion. Biological sex plays a large role in the choices students make to pursue or avoid scientific careers. Evolutionary tendencies, biochemical processes, and social reinforcements generate a division in the field of science. Males favor physical sciences, technology, engineering and mathematics. Females favor biological sciences and medicine.

Research shows that students consider career options during their middle school years and that differences in subject preferences are already apparent at that level.

Value of Science to Society

The value of science to society can be defined as “students’ attitudes toward the discoveries and technological advances that occur through STEM” (Hillman et al., 2016, p. 207). In science education research, the value of science can further be described as “the utility of science in everyday life and for future careers” (George, 2006, p. 572). Because value of science is perceived by students as the advancements made in society through STEM processes, value may also be considered usefulness as it applies to societal contributions. Positive attitudes toward the value of science are associated with positive attitudes toward science overall (George, 2006).

Middle school and high school students have a fairly positive view of the value of science in their daily lives (George, 2003, 2006). These students rate the value of science highly, even when they report having little interest in studying science (Desy et al., 2011). Students’ attitudes toward the value of science seem to remain constant through the elementary, middle, and high school levels (Ali et al., 2013). Specifically, attitudes toward the value of science for future careers of students have been shown to steadily decline with grade level, however (Ali et al., 2013; George, 2006). When this is the case, fewer students enroll in programs that will lead to careers in science (Ali et al., 2013). The decline in attitudes toward value of science may be impacted by the science subjects taught at each grade level (George, 2006). The physical sciences are usually offered in higher grade levels when students show a decreased appreciation for the value of science (George, 2006). Additionally, the science courses offered in most schools become increasingly advanced with grade level and may be too technical for many students to see the practical implications these sciences have on their daily lives (George, 2006).

Utility values can be further broken down into self-focused and other-focused value domains (Brown et al., 2015). Values that are considered self-focused are driven by achievement and autonomy (Brown et al., 2015). These values are agentic and in line with stereotypical perceptions of scientific career fields (Brown et al., 2015). Other-focused values are driven by the need to help others and to develop affiliation (Brown et al., 2015). Other-focused values are also considered communal (Brown et al., 2015). STEM fields are not known for holding communal value (Brown et al., 2015). Agentic and communal utility values are independent so students may perceive one to be high and the other low, both to be high, or both to be low (Brown et al., 2015). They can also change over time and may be affected by interventions (Brown et al., 2015).

Students become more interested in science, and therefore more likely to pursue careers in science, when they see the practical significance of science as a contributor toward society (George, 2006). Specifically, communal utility value has shown to influence the willingness of students to pursue science careers (Brown et al., 2015). When students were aware of the communal utility of science, their motivation for science increased (Brown et al., 2015). The students' perceptions of the agentic value in science was not affected by their increased perception of communal utility in science (Brown et al., 2015).

A positive attitude toward the value of science to society is not necessarily enough to convince students to pursue scientific degrees and careers. Kim and Song (2009) observed positive attitudes toward the value of science among middle school and high school students. This attitude, however, had no effect on the desire of these students to become future scientists

(Kim & Song, 2009). Attitudes toward learning school science and attitudes toward future scientific careers remained low even for students believing science to be valuable in life (Kim & Song, 2009). Kim and Song recommend that teachers and educational researchers focus on improving intrinsic interest in school science rather than the utility of science to promote scientific career interest.

Science values are greatly affected by informal science experiences that occur outside of the classroom (Bathgate & Schunn, 2017). Examples of informal science experiences could be a trip to a museum, nature center visit, or camping trip with family members (Bathgate & Schunn, 2017). Students' perceptions of the value of science are improved through optional science activities (Bathgate & Schunn, 2017). These opportunities most likely improve utility values because they are authentic experiences that connect classroom science to students' daily lives (Bathgate & Schunn, 2017). Additionally, for students with low-quality science classes, outside activities provide supplemental education that allow the students to appreciate the value of science (Bathgate & Schunn, 2017).

Males' perceived value of science to society. It is not clear to what extent male students' attitudes toward science vary based on perceived value of science. Blanchard Kyte and Riegle-Crumb (2017) found that male students' attitudes toward science were unaffected by their perceptions of science value. Furthermore, the perceived value of specific disciplines within science did not seem to affect male students' interests in them (Blanchard Kyte & Riegle-Crumb, 2017). Blanchard Kyte and Riegle-Crumb (2017) offer gender theory in explanation for these patterns suggesting that male students are typically less moved by the desire to help others. Male students' perceptions of the social relevance of science would then be unimportant in their decisions to pursue such careers (Blanchard Kyte & Riegle-Crumb, 2017). In contrast, George

(2003, 2006) and Brown et al. (2015) demonstrated a link between perceived science utility and attitude toward science. Recognition of the value of science improves the potential for students to pursue science careers (Brown et al., 2015; George, 2006).

The association between science value and attitudes toward science for male students may be less clear than that for female students because the need for social relevance is more deeply embedded in females. Male students are affected by both agentic and communal utility values (Brown et al., 2015). Though females are traditionally more focused on affiliation while males are more focused on agency, both utility value domains can be important to members of each biological sex. Males are still impacted by communal values because relatedness and belonging are universal human characteristics (Brown et al., 2015).

Females' perceived value of science to society. Female students who perceive science as socially relevant are more likely to enter science, technology, engineering, and mathematics (STEM) career fields (Blanchard Kyte & Riegle-Crumb, 2017). Females are more likely to pursue careers in STEM fields when they recognize the utility of science overall (Blanchard Kyte & Riegle-Crumb, 2017). Furthermore, interest in specific career fields, such as biology, physical science, and engineering, increases significantly for girls with greater recognition of each field's social relevance (Blanchard Kyte & Riegle-Crumb, 2017).

Females, by nature, are more altruistic than males and seek opportunities to benefit others or society (Beyer, 2014). Evolutionary psychology demonstrates the deep-rooted instinct for females to nurture and build relationships (Eagly & Wood, 1999). Neurochemical processes generate a reward signal when women adhere to their nurturing nature (Eagly, 2009). Due to this altruistic desire, females continue to consider the value a subject, such as science, holds for society in determining their attitudes toward it.

Else-Quest et al. (2013) reported that female students perceived greater value in science than male students. This result was surprising because the underrepresentation of women in science would suggest women may not value science as much as men (Else-Quest et al., 2013). The researchers speculated "female adolescents' more negative expectations for success mitigate the effects of their greater perceived science task value, such that they decide not to pursue science despite believing that it is valuable" (Else-Quest et al., 2013, p. 303). Lower perceived self-efficacy in science may deter female students from pursuing scientific careers rather than a negative view of the value of science to society. An alternate interpretation suggested by Else-Quest et al. was that female students were reporting their perceived value of the specific fields of science they were currently learning in school rather than the value of science overall.

In contrast to George's (2006) findings, Jenkins and Nelson (2005) found that school science was not able to foster an appreciation for the importance of science in society among female middle school students. Furthermore, Tseng, Chang, Lou, and Chen (2013) found that these students were able to identify negative implications of science and technology for society. In their study, some students reported positive views of the value of science to society while other students discussed the problems associated with current technological fields (Tseng et al., 2013). These students suggested future technology should focus on protecting the environment and solving the problems technology itself has caused (Tseng et al., 2013).

Conclusion. Students' attitudes toward the value of science impact their overall attitudes toward science as a subject as well as their willingness to pursue scientific careers. Overall, a greater appreciation for the value science holds for society is associated with more positive views of science. Both male and female students have demonstrated this correlation which stems from a universal human need for affiliation and belonging.

Perceptions of Scientists

Perceptions of scientists is the stereotypical ideation of scientists held by students (Hillman et al., 2016). The stereotypical belief that scientists are men and science is a masculine domain is referred to in the literature as the gender-science stereotype (Cai, Luo, Shi, Liu, & Yang, 2016; Miller et al., 2015).

The gender-science stereotype is a well-known phenomenon (Cai et al., 2016; Miller et al., 2015). Students typically expect men to work as scientists (Cai et al., 2016; Miller et al., 2015). The gender-science stereotype is controlled by several factors including genetics and the environment (Cai et al., 2016). An individual's genetic makeup can contribute to an intrinsically biased or intrinsically sensitive attitude toward stereotypes (Cai et al., 2016). Genes of biased individuals can cause behaviors that further endorse gender stereotypes; these individuals develop stereotype-consistent conditions in their environments which only further strengthen their stereotypical perceptions (Cai et al., 2016).

Perceptions developed biologically are strengthened through social interactions. Social role theory (2012) postulates that gender stereotypes form and change as a result of behavioral observations (Miller et al., 2015). Young children develop stereotypical perspectives based on their observations of males and females participating in differing social roles (Miller et al., 2015). These perceptions can later be amended through interventions or through observations that vary from those experienced in childhood (Miller et al., 2015). In the case of science, females' beliefs that science-is-male may be improved through interactions with female science teachers and exposure to female scientists (Miller et al., 2015).

Middle school students have been found to identify scientists with stereotypical scientist traits in numerous studies through the use of the Draw-a-Scientist test (Fralick, Kearn, Thompson, & Lyons, 2009; Schibeci, 2006). Most students draw scientists as males though slightly more female scientists are drawn after intervention programs (Fralick et al., 2009; Schibeci, 2006). Middle school students also include stereotypical items such as lab coats, test tubes, and glasses or goggles in their pictures of scientists (Fralick et al., 2009; Schibeci, 2006). These patterns are consistent with students in other age groups and have remained constant for over 50 years (Schibeci, 2006). It is possible that students' stereotypical perceptions have persisted through generations, or it is possible there are flaws in the design of the test. The Draw-a-Scientist test may simply reflect what students understand to be the societal scientist stereotype rather than their own personal beliefs of what scientists could be (Fralick et al., 2009; Schibeci, 2006).

Males' perceptions of scientists. The stereotypical belief that science is for men is stronger in males with strong "science self-concepts" (Smyth & Nosek, 2015, p. 4). Males in science, technology, engineering, and mathematical (STEM) fields have stronger associations with the science-is-male stereotype than males working in non-STEM professions (Smyth & Nosek, 2015). Smyth and Nosek (2015) suggest that "this pattern makes clear that this implicit stereotype is not simply a socially-shared association acquired through cultural exposure" but is a combination of factors including gender identity and science/art identity (p. 10). The combination required to determine the extent of one's stereotypical beliefs can be understood through Greenwald et al.'s (2002) balanced identity theory (BIT) (Smyth & Nosek, 2015). According to the theory, the group with which one associates (e.g., male or female), the attribute the individual possesses (e.g., science or art identity), and the stereotype in which one believes (e.g., science-is-male) balance one another (Smyth & Nosek, 2015). A change in one factor forces a balancing change in another (Smyth & Nosek, 2015). The stereotype is stronger for males in science because their actions reinforce their own stereotypical beliefs.

Females' perceptions of scientists. The long-standing stereotypes of scientists as men have a negative impact on female students interested in science (Hong & Lin, 2011; Quinn & Cooc, 2015). In fields such as computer science, people entering the career field are considered "nerds, geeks, or hackers" lacking interpersonal skills (Beyer, 2014, p. 155). These long-standing stereotypes negatively affect student course choice and choice of majors in college (Beyer, 2014). Many female students report liking science but that a scientific career is "not for me" (Archer et al., 2013). These students do not view themselves as potential scientists because their perceptions of scientists have been so negatively affected by stereotypes (Farland-Smith, 2009; Quinn & Cooc, 2015).

Females in STEM occupations were found to have weaker science-is-male stereotypical beliefs than females in non-STEM careers (Smyth & Nosek, 2015). Females working in physics and biology also had weaker science-is-male beliefs than females in computer and health sciences (Smyth & Nosek, 2015). The females in STEM fields were most affected by their own self-concepts over societal stereotypes or gender ratios in their fields (Smyth & Nosek, 2015). When a female student or scientist has a strong understanding of herself as both a female and as an individual in science, her self-concept becomes impervious to external factors (Smyth & Nosek, 2015).

Gender schema theory can be used to explain children's perceptions of what is acceptable for males and females (Weisgram & Bigler, 2006). According to this theory, children use environmental information as they get older to determine what roles, behaviors, and eventual career choices align with each biological sex (Weisgram & Bigler, 2006). The notion that science and technology are masculine domains prevents many female students from participating in science activities (Francis et al., 2017; Weisgram & Bigler, 2006). Children increasingly feed into this stereotype as they grow older believing that science is a male domain while the humanities are a female domain (Liu et al., 2010). Though the perception increases in magnitude with age for both male and female students, it is stronger for females than it is for males in the middle school (Liu et al., 2010).

A study performed by Gokhale et al. (2015) demonstrated a change in the stereotypical beliefs held by both males and females, however. Both sexes were more accepting of non-traditional roles for the opposite sex (Gokhale et al., 2015). This finding could suggest hope for a change in the future as to what is accepted as typical for each biological sex.

Researchers have studied the success of programs aimed at changing children's perceptions of scientists. Specifically, many programs have been initiated targeting elementary and middle school females in an attempt to change their perceived stereotypes. Opportunities for female students to work closely alongside scientists, for example, provides female students with the opportunity to visualize women in science careers (Farland-Smith, 2009).

A study by Weisgram and Bigler (2006) showed that female students' levels of egalitarianism were unaffected by an intervention program. Female students attended a program where all scientist presenters were female (Weisgram & Bigler, 2006). The exposure to female scientists improved the students' self-efficacy in science (Weisgram & Bigler, 2006). The female students also reported finding science more important to their future after participation in the program (Weisgram & Bigler, 2006). The unexpected negative impact produced through the program was that it did not change their views of the profession being male-dominated; instead, fewer female students endorsed egalitarianism in science (Weisgram & Bigler, 2006).

Though female role models may prove successful at changing stereotypes in some cases, they may reinforce the stereotypes in others. When the stereotype aligned with a given career field is negative, such as nerdy or geeky, it can be detrimental to female students to interact with role models who exemplify the stereotype (Beyer, 2014). The young women will continue to view the careers in a biased way rendering the female role models unsuccessful in inspiring the students (Beyer, 2014).

Conclusion. "Stereotypes are powerful influencers of behavior" (Beyer, 2014, p. 155). The most notable stereotype held by students is that science is a male domain. This belief encourages male students to pursue the subject and dissuades female students from science pursuits. Middle school students also have a limited understanding of scientists assuming that lab coats and test tubes are part of most scientists' jobs. The stereotypes held by all students begin biologically through genetic factors but are reinforced consistently through environmental conditions. According to balanced identity theory, increasing female students' science identities requires a change in science-is-male stereotypes.

Summary

This review of the literature demonstrated that differences still exist in some areas of science for male and female students. The gender gap that has been studied for several decades is closing in certain fields of science, such as biology and veterinary medicine, while persisting in others, such as computer science and engineering. Expectancy-value theory and Bandura's (1997) social cognitive theory can be used to interpret students' attitudes toward science at the middle school level. Gender theories, such as gender schema theory and social role theory, explain the underpinnings of differences in students' attitudes based on biological sex. Gottfredson's (1981) theory of circumscription and compromise explains the process in which children go about eliminating potential career options as they grow up. Students' attitudes toward science influencing their career choices can be divided into their attitudes toward school science, desire to become scientists, value of science to society, and perceptions of scientists. Differences in attitude based on biological sex have been explored in the extant literature through each of these constructs showing female students' attitudes toward science tend to decline more rapidly than the attitudes of male students.

CHAPTER THREE: METHODS

Overview

The attitudes toward science of sixth, seventh, and eighth grade students will be compared based on biological sex. This chapter will explain the research design that was used to effectively make comparisons between groups. The research question and null hypothesis will be presented. Participants and setting will be discussed including demographic information for the participating school district. The instrumentation and procedure will be addressed, and data analysis will be discussed.

Design

A causal-comparative research design was used in this study. This design is most appropriate for the chosen research question as the groups being compared were formed naturally based on the biological sex of the students. The goal was to examine differences that are caused by preexisting variations in the populations of students (Gall, Gall, & Borg, 2007). In this case, the self-reported biological sex of the students is the independent variable. The students' attitudes toward school science, desire to become scientists, the value of science to society, and perceptions of scientists are the four dependent variables. Students' attitudes toward science are their feelings toward the behavior of participating in school science classes (Hillman et al., 2016). The value of science to society is defined for this study as the "students' attitudes toward the discoveries and technological advances that occur through STEM" (Hillman et al., 2016, p. 207). Desire to become a scientist is simply a student's "interest in a scientific career" (Hillman et al., 2016, p. 207). Perceptions of scientists is defined as the stereotypical ideation that students hold of scientists (Hillman et al., 2016).

Research Question

The research question for this study was:

RQ1: To what extent do attitudes toward school science, desire to become a scientist, value of science to society, and perceptions of scientists of male and female middle school students differ as measured by the My Attitudes Toward Science instrument?

Null Hypothesis

The null hypothesis for this study was:

$H_0$1: There is no significant difference in attitudes toward school science, desire to become a scientist, value of science to society, and perception of scientists of male and female middle school students as measured by the My Attitudes Toward Science instrument.

Participants and Setting

Population

The participants for this study were selected through the method of convenience sampling of middle school students located in the state of New Jersey during the 2017-2018 school year. For both schools participating in the study, 51-52% of the student population are female students. In all cases, roughly 75% of the student population lives in family households with more than half of the students coming from homes with married parents. Between 68% and 72% of the families are considered “white collar” earning a yearly average of $100,000 in household income. The county consists of 63% Caucasian, 11% African American, 24% Asian, and 20% Latino or Hispanic residents while the remaining 4% identify as other races. Free and reduced lunch assistance is used by 41% of students in the state but only by 29% in participating schools suggesting a lower poverty level in the participating township.

Sample

Eighteen classes each from two middle schools were included in the sample for a total of thirty-six classes. Participants for this study were selected from general education science classes in the sixth, seventh, and eighth grades in each of the participating schools. The sample did not include advanced placement, honors, or resource level classes but instead focused solely on general education track students. For this study, the total number of participants sampled was 487 which exceeded the required minimum for a medium effect size. According to Gall et al. (2007), 166 students is the required minimum for a medium effect size with statistical power of .7 at the .05 alpha level. Ten students did not report their biological sex and were thus removed from the study. Additionally, 16 students were removed from the sample because they failed to complete the entire survey. Six other students were removed because they no longer wished to participate after beginning the survey. Five more surveys were removed from the sample after the researcher determined these surveys to be outliers. The resulting sample consisted of 198 males and 252 females for a total sample size of 450 participants. Students ranged in age from 10 through 15 years old, averaging 12.3 years of age. The ethnic breakdown of the participating students was 44.4% Caucasian, 17.2% Asian, 12.1% of other races, 9.8% Bi-racial, 9.0% Latino or Hispanic, and 7.1% African American. Two students did not specify their race. The grade levels included in the sample were sixth, seventh, and eighth grade with 117 sixth, 196 seventh, and 137 eighth grade students. All classes recruited use a spiral curriculum model sharing instructional time among the major science disciplines--earth, life, and physical--throughout the year at each grade level.

Groups

Group 1 (Male students). The first group consisted of 45 sixth grade, 85 seventh grade, and 68 eighth grade male students for a total of 198 male students. The ethnic breakdown of the participating students was 44.9% Caucasian, 12.6% Asian, 9.5% other races, 8.7% African American, 8.3% Latino or Hispanic, and 6.7% Bi-racial. The average age of these students was 12.4 years old.

Group 2 (Female students). The second group consisted of 72 sixth grade, 111 seventh grade, and 69 eighth grade female students for a total of 252 female students. The ethnic breakdown of the participating students was 45.6% Caucasian, 20.2% Asian, 11.1% Bi-racial, 10.3% other races, 7.5% Latino or Hispanic, and 4.4% African American. Two female students did not specify their race. The average age of these students was 12.2 years old.

Instrumentation

The My Attitudes Toward Science (MATS) instrument was used to measure middle school students' attitudes toward science based on biological sex. The instrument was designed by Hillman et al. (2016) in response to the inadequate measurements of science attitudes already in existence. Many studies have been cited using instruments without proper reliability or validity documentation jeopardizing their results (Hillman et al., 2016). Many existing instruments were designed for use within specific age groups making it harder to generalize results across grade levels (Hillman et al., 2016). Others focus heavily on one type of science rather than attitudes toward science in general. Furthermore, Hillman and colleagues argued for an instrument with subscales that could measure the multidimensional nature of a child's attitude towards science. The MATS instrument has four subscales. The subscales are attitudes toward school science, desire to become a scientist, value of science to society, and perception of scientists.

The instrument went through a number of rigorous field tests to demonstrate its reliability and validity. Items were reviewed by teachers, researchers, and graduate students to assess reliability. All statements included in the final version of the MATS instrument passed 80% inter-rater reliability with most reaching 90% (Hillman et al., 2016). The easy readability of each item makes the survey appropriate for use in any grade level (Hillman et al., 2016). Twenty-four classrooms with a total of 549 students participated in the field test of the survey (Hillman et al., 2016). The students ranged in grade level from elementary through high school (Hillman et al., 2016). Analysis of Cronbach's alpha coefficients showed internal consistency for each of the subscales across many grade levels (Hillman et al., 2016). The Cronbach's alpha coefficients for the attitude toward school science, desire to become a scientist, and value of science to society subscales were found to be .866, .700, and .794 respectively (Hillman et al., 2016). The perception of scientists subscale showed a lower coefficient (.539) indicating students' perceptions were not homogenous (Hillman et al., 2016). This is most likely due to the change in stereotypes children perceive today, but the subscale can still be used in the total to suggest how strong students' associations are with stereotypical scientist traits (Hillman et al., 2016).

The final instrument consists of 40 items representing the four subscales of students' attitudes. The entire survey takes fewer than 20 minutes for the students to complete. It is formatted with 5 point Likert-type responses. The responses are as follows: Disagree a lot = 1, Disagree a little = 2, Have not decided = 3, Agree a little = 4, and Agree a lot = 5. The statements appear in a random order on the survey rather than appearing together in complete subscales. Each subscale consists of an equal number of positively and negatively worded statements. The attitude toward school science subscale contains 14 items allowing each student's score to total between 14 points, indicating the most negative attitude toward school science, and 70 points, indicating the most positive attitude toward school science. The desire to become a scientist subscale only contains two items so that each student's score could fall between 2 and 10 points. The value of science to society subscale contains 12 items allowing potential scores to fall between 12 and 60 points. For the perceptions of scientists subscale, a higher score represents a more stereotypical ideation of scientists where 60 is the highest possible score and 12 is the lowest possible score (Hillman et al., 2016).

Permission to use the MATS instrument was obtained from Dr. Hillman of the University of New England with the expectation that the MATS instrument and related information would be cited appropriately in all future studies. See Appendix A for permission to use the instrument.

Procedures

Permission to conduct this study was secured through Liberty University's Institutional Review Board (IRB) prior to gathering any data. See Appendix B for IRB approval. Parental consent and child assent were both obtained in accordance with IRB policy. The consent form can be found in Appendix C.

Participating schools were selected in close proximity to one another geographically and are a part of the same suburban school district. The superintendent for the selected school district was contacted through email to request participation in the study. See Appendix D for superintendent's agreement to participate. Subsequent discussions about the procedure and administration of the survey to students took place with the superintendent through email. Once permission was granted by the superintendent, emails were sent out to specific building principals and middle school science teachers to discuss availability and willingness for participation in the study. Twelve teachers from were recruited for participation. These teachers each had three classes of general education students eligible to participate for a total of 36 classes. Teachers contacted for participation all teach integrated middle school science courses. The integrated science courses provide instruction in the subjects of physical science, life science, and Earth science at every grade level. The responses from teachers were positive due to professional relationships with the researcher. Teachers agreed to administer the survey to the students during regular class time within the science period and were assured its duration would be no longer than 20 minutes.

The MATS instrument was administered by the students' science teachers during the fall semester of the 2017-2018 school year. Parent permission forms were distributed to the volunteer teachers two weeks before data collection was scheduled to begin. The teachers were asked to send home the parent permission forms with the students. These forms were then returned to the volunteer teachers who turned them over to the researcher on the day of data collection.

Each volunteer teacher was provided with a set of written instructions to read to the class on the day the survey was administered. See Appendix E for instructions. The teachers also received reward pencils for students participating, copies of the survey, gift cards for themselves, and an envelope for each student. On the day data were collected, the students with parental consent and child assent signatures were the only students offered the survey. Students not participating in the study quietly worked on other assignments allowed by their science teachers. The students participating in the study were asked to complete the survey by using pencils to darken circles for the number that most represents their attitudes toward each survey item. The fill-in-the-circle format is familiar to the students as similar answer sheets are used for large assessments like schoolwide exams and state tests. The students were provided half of their science class period, or roughly 20 minutes, to complete the survey. Once they finished, students sealed their forms in individual envelopes. Students then read a book or quietly worked on other assignments after they had completed the survey. The sealed envelopes were collected by the volunteer teachers once the students had all finished. These sealed envelopes were then placed in larger manila envelopes and collected by the researcher at the end of the day.

The combined data from all classes was coded, entered into an Excel spreadsheet, and analyzed by SPSS software. Reverse coding was necessary for the first three subscales before data analysis could take place.

Data Analysis

The data analysis used in this study was the multivariate analysis of variance (MANOVA). This test was selected so that comparisons could be made on multiple dependent variables between the two groups (Warner, 2013). Data screening was conducted to look for data entry errors or data inconsistencies. Several data entry errors were discovered and corrected. Outliers were identified using z-scores and box and whiskers plots. Five outliers were identified and removed from the sample. The descriptive statistics were calculated and reported. Normality was tested using the Kolmogorov-Smirnov test. The Box's M test was used to assess the equality of covariance. The *F*- statistic was reported at the alpha level of .05. Partial η^2 was be used to measure effect size.

CHAPTER FOUR: FINDINGS

Overview

This chapter will review the research question and null hypothesis for the study. Descriptive statistics for the four dependent variables will be provided. Data screening and assumption tests will be discussed. Analysis methods and results will be provided.

Research Question

The research question for this study was:

RQ1: To what extent do attitudes toward school science, desire to become a scientist, value of science to society, and perceptions of scientists of male and female middle school students differ as measured by the My Attitudes Toward Science instrument?

Null Hypothesis

The null hypothesis for this study was:

$H_0$1: There is no significant difference in attitudes toward school science, desire to become a scientist, value of science to society, and perception of scientists of male and female middle school students as measured by the My Attitudes Toward Science instrument.

Descriptive Statistics

Data obtained for the dependent variables, attitudes toward school science, desire to become a scientist, value of science to society, and perceptions of scientists can be found in Table 1. On average, males' attitudes toward school science (M = 56.07, SD = 9.70) was slightly greater than females' (M = 54.04, SD = 10.84). Males' desire to become scientists (M = 5.49, SD = 2.28) was slightly greater than females' (M = 5.17, SD = 2.34). Females indicated higher values of science to society (M = 48.52, SD = 6.65) than males (M = 48.15, SD = 7.28); however, male (*M* = 27.56, *SD* = 5.16) and female (*M* = 27.47, *SD* = 4.86) students' perceptions of scientists were nearly the same.

Table 1

Descriptive Statistics

Attitude Domain	Biological Sex	Mean	*SD*	*N*
Attitude Toward School Science	Male	56.07	9.70	198
	Female	54.04	10.84	252
	Total	54.93	10.39	450
Desire to Become a Scientist	Male	5.49	2.28	198
	Female	5.17	2.34	252
	Total	5.31	2.32	450
Value of Science to Society	Male	48.15	7.28	198
	Female	48.52	6.65	252
	Total	48.36	6.93	450
Perceptions of Scientists	Male	27.56	5.16	198
	Female	27.47	4.86	252
	Total	27.51	4.99	450

Results

Data Screening

Data screening was conducted on each group's dependent variables (attitudes toward school science, desire to become a scientist, value of science to society, and perceptions of scientists) to search for inconsistencies and extreme outliers. A few minor inconsistencies, such as missing data points, were found and corrected upon screening. Z scores were calculated for each dependent variable revealing four extreme outliers exceeding +/- 3.30 (Warner, 2013). Two of these were removed from the females' attitudes toward school science group. Another outlier was removed from the females' value of science to society group, while the final outlier was removed from the males' perception of scientists group. Box and whiskers plots show the remaining sample across each of the four dependent variables. Figure 1 shows the box and whiskers plot for attitudes toward school science, Figure 2 shows the box and whiskers plot for desire to become a scientist. Figures 3 and 4 show box and whiskers plots for value of science to society and perceptions of scientists, respectively.

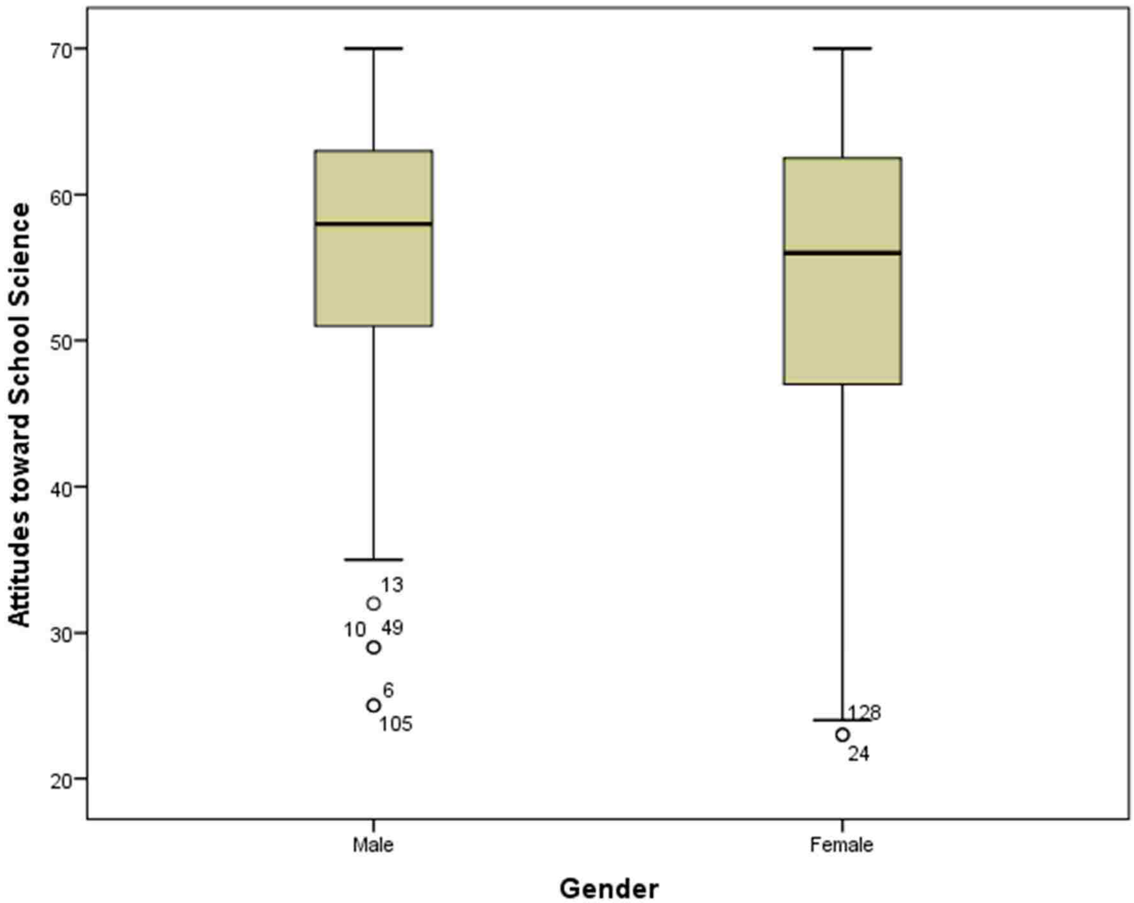

Figure 1. Box and Whiskers Plot for Attitudes toward School Science

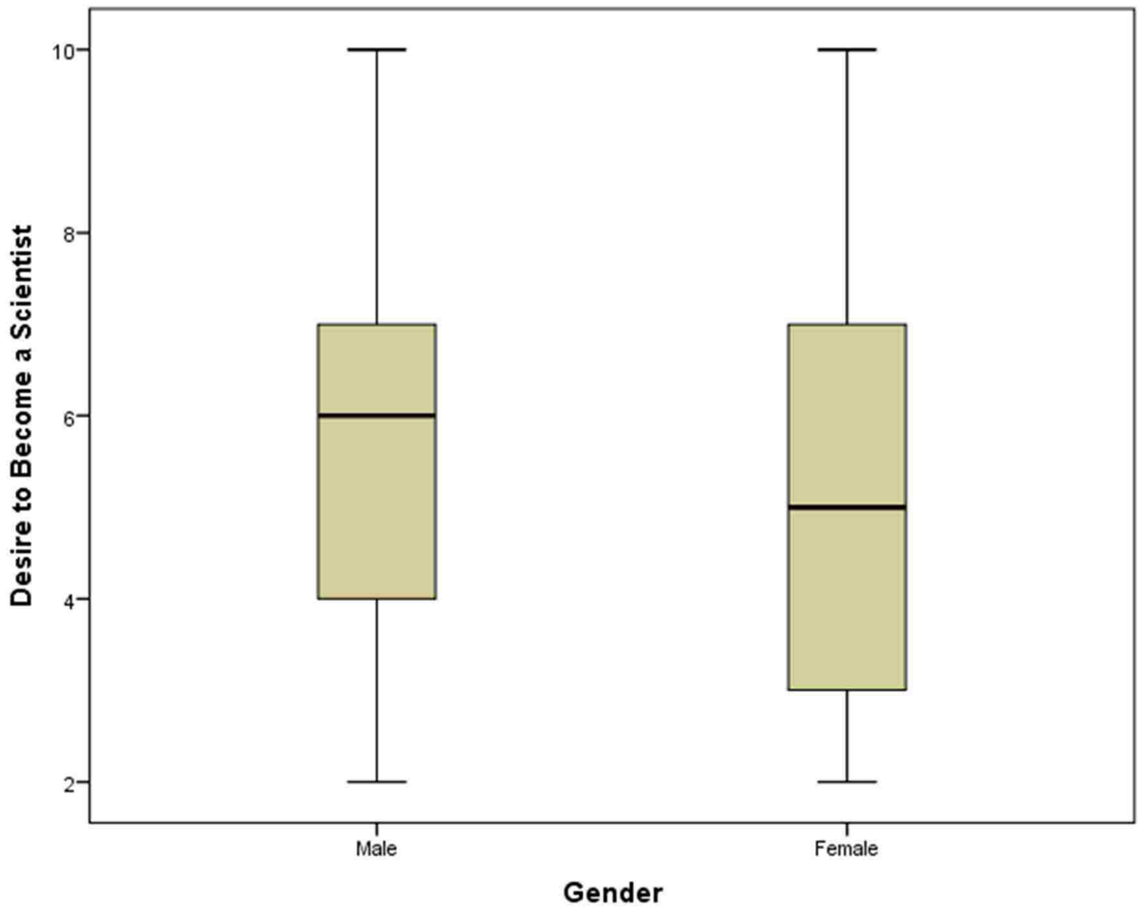

Figure 2. Box and Whiskers Plot for Desire to Become a Scientist

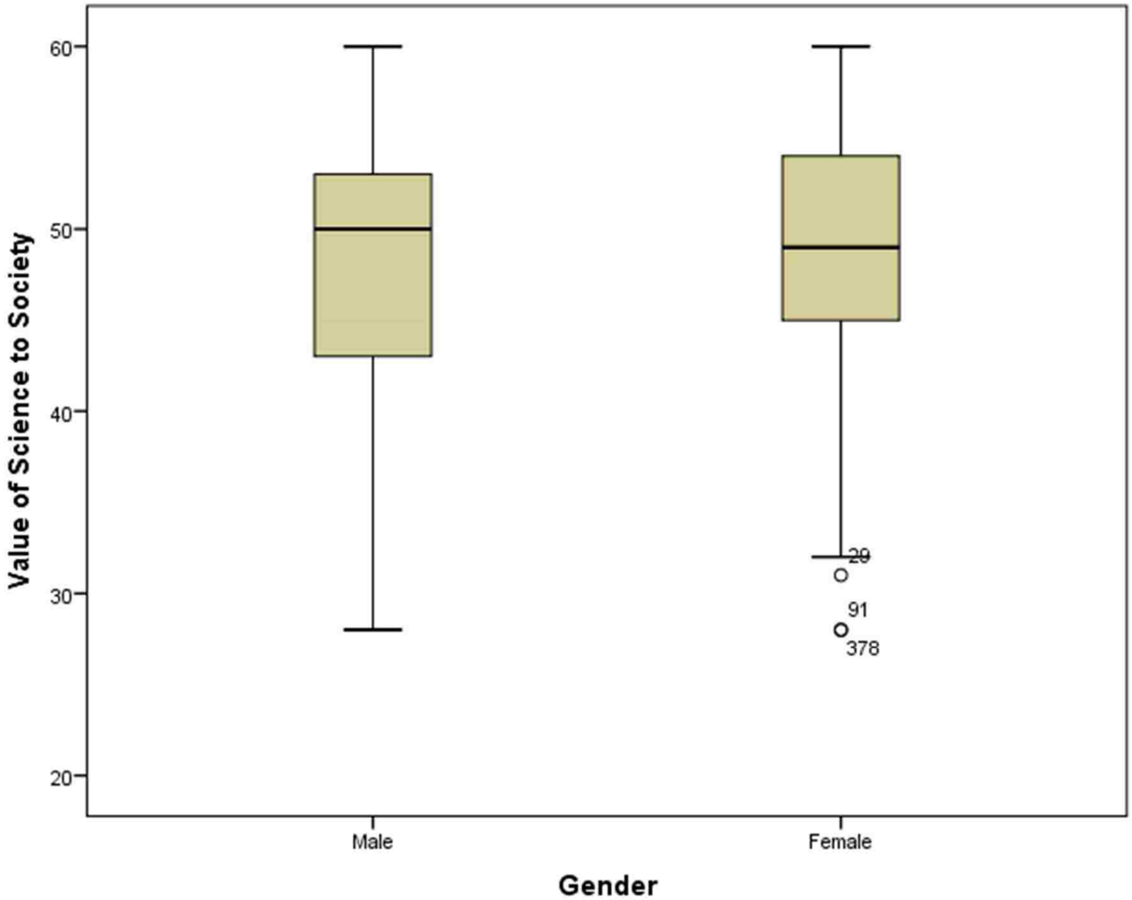

Figure 3. Box and Whiskers Plot for Value of Science to Society

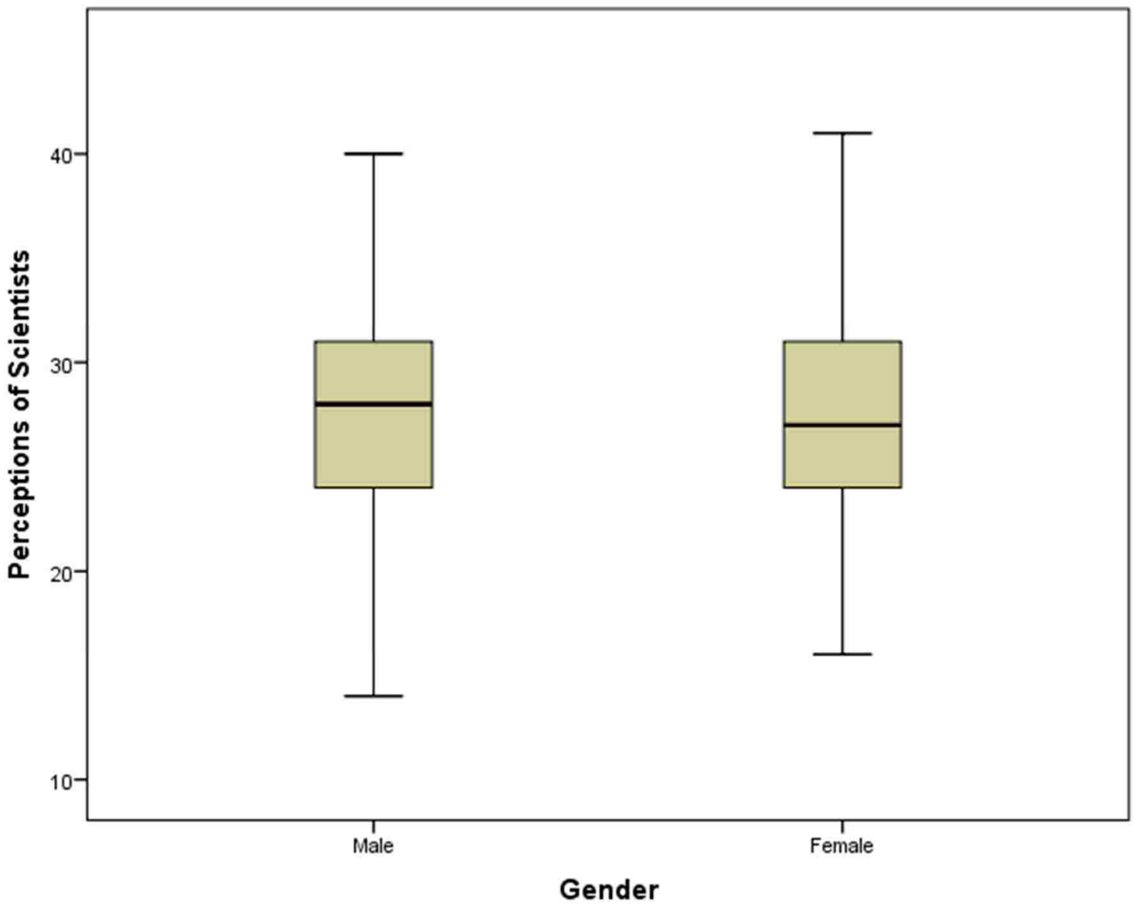

Figure 4. Box and Whiskers Plot for Perceptions of Scientists

Assumptions

A one-way multivariate analysis of variance (MANOVA) was conducted to evaluate the differences in attitudes between male and female middle school students toward school science, desire to become scientists, value of science to society, and perceptions of scientists. The assumptions of normality, multivariate normal distribution, and homogeneity of variance were tested to determine validity of the data.

Normality was assessed using a Kolmogorov-Smirnov test. See Table 2 for Tests of Normality. According to the test, the assumption of normality was violated. The researcher generated a series of histograms to further examine normality of the sample across each subscale.

Table 2

Kolmogorov-Smirnov Tests of Normality

Attitude Domain	Biological Sex	Statistic	df	*p*
Attitude Toward School Science	Male	.130	198	.000
	Female	.106	255	.000
Desire to Become a Scientist	Male	.158	198	.000
	Female	.120	255	.000
Value of Science to Society	Male	.116	198	.000
	Female	.084	255	.000
Perceptions of Scientists	Male	.088	198	.001
	Female	.066	255	.010

A visual inspection of the histograms revealed relatively normal distribution patterns. Some skewness was observed in the histograms for the attitudes toward school science, desire to become a scientist, and value of science to society subscales. This skewness likely results from flaws inherent to the use of Likert-scale instruments. In such scales, there is not enough variability to allow for true normality. However, the researcher used a series of QQ plots to continue assessing normality. See Figure 5 for histograms of attitudes toward school science of male and female middle school students. See Figure 6 for histograms of the desire to become a scientist for male and female middle school students. Figure 7 shows histograms for students' value of science to society construct, and Figure 8 shows histograms of perceptions of scientists for male and female middle school students.

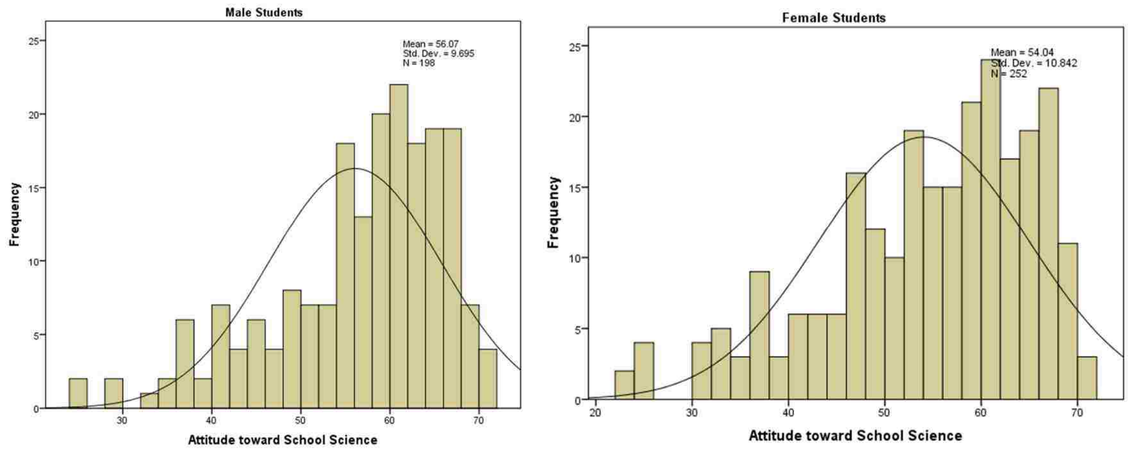

Figure 5. Histograms for Attitudes toward Science of Male and Female Middle School Students

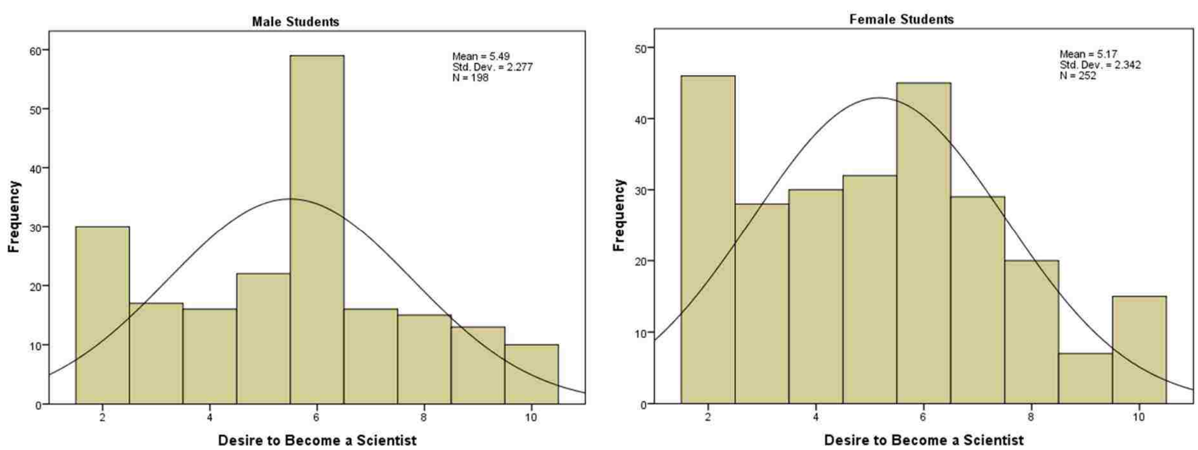

Figure 6. Histograms for Desire to Become a Scientist of Male and Female Middle School Students

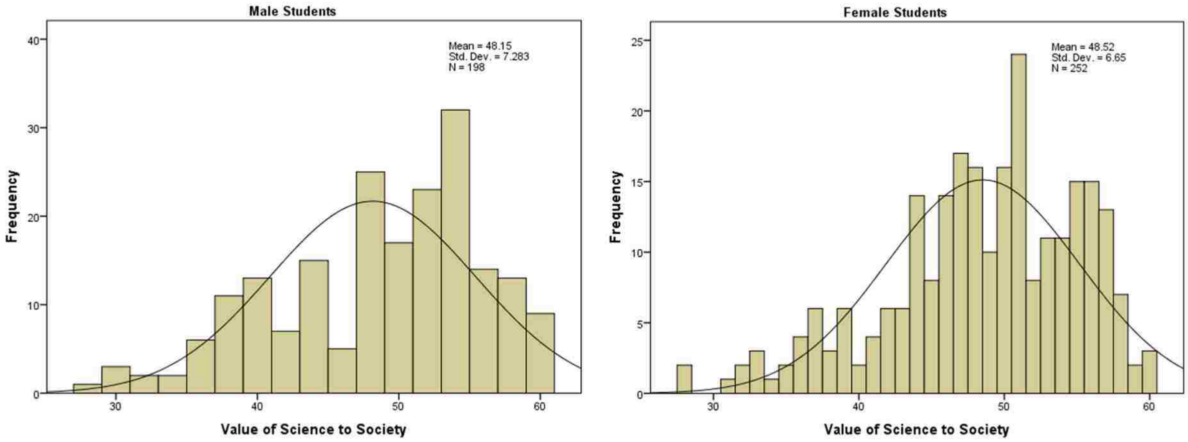

Figure 7. Histograms for Value of Science to Society of Male and Female Middle School Students

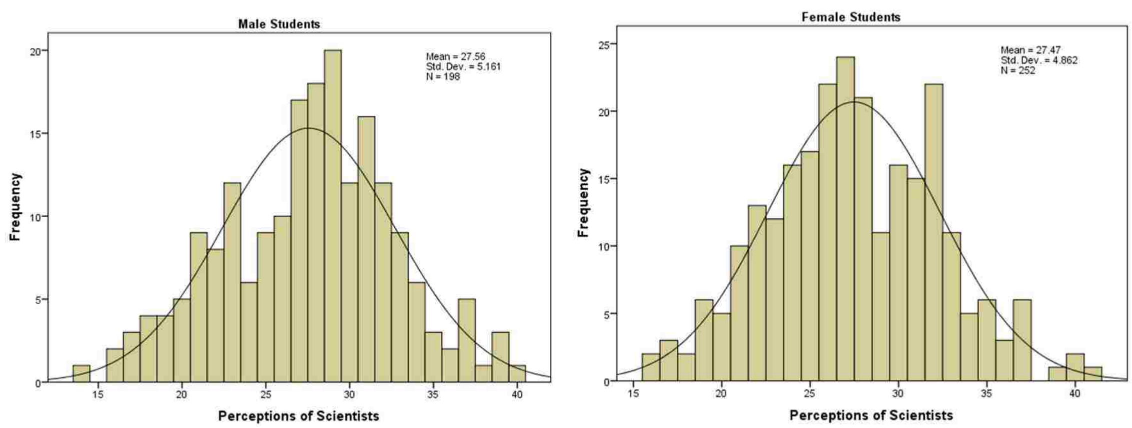

Figure 8. Histograms for Perceptions of Scientists of Male and Female Middle School Students

A visual inspection of the QQ plots revealed closer to normal distribution patterns. Additionally, "even when the data are not multivariate normal, the multivariate normal may serve as useful approximation" (Rencher, 1995, p. 94). The central limit theorem permits normality violation with large enough sample sizes, as those seen in the present study, to the extent that analysis could be continued (Rencher, 1995). See Figure 9 for the QQ plot of attitudes toward school science of male and female middle school students. See Figure 10 for the QQ plot of the desire to become a scientist for male and female middle school students. Figure 11 shows the QQ plot for students' value of science to society construct, and Figure 12 shows the QQ plot of perceptions of scientists for male and female middle school students.

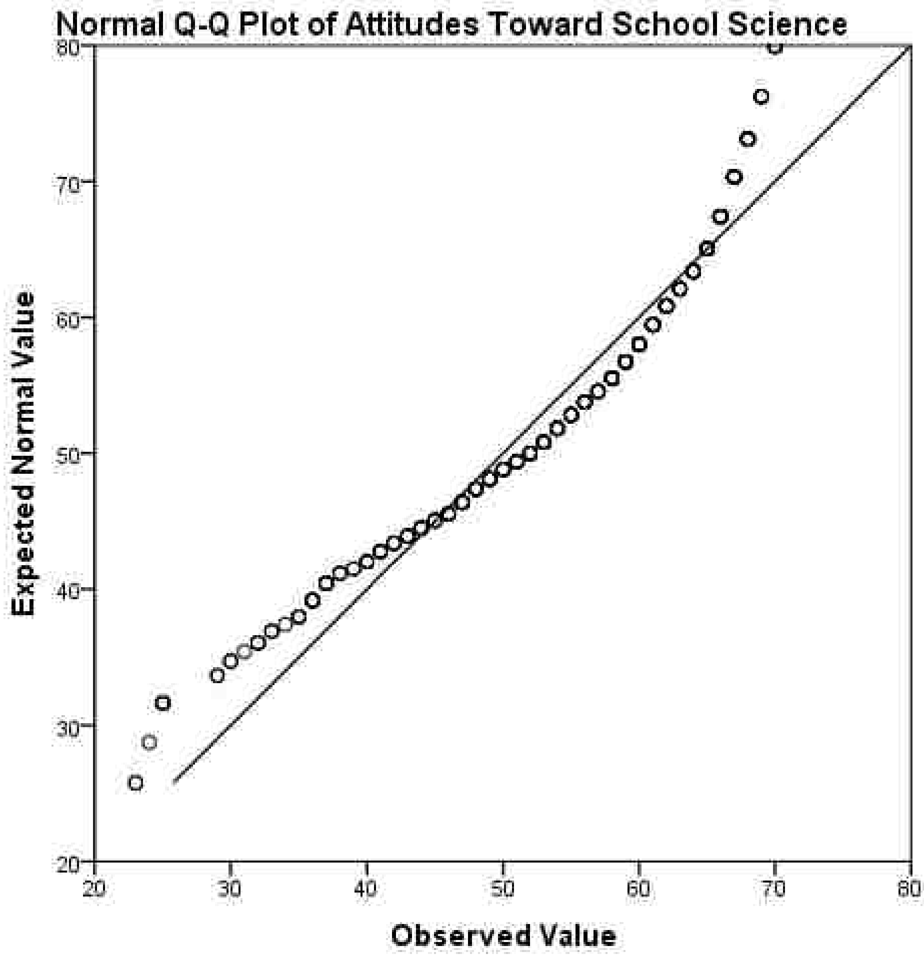

Figure 9. QQ Plot for Attitudes toward School Science of Male and Female Middle School Students

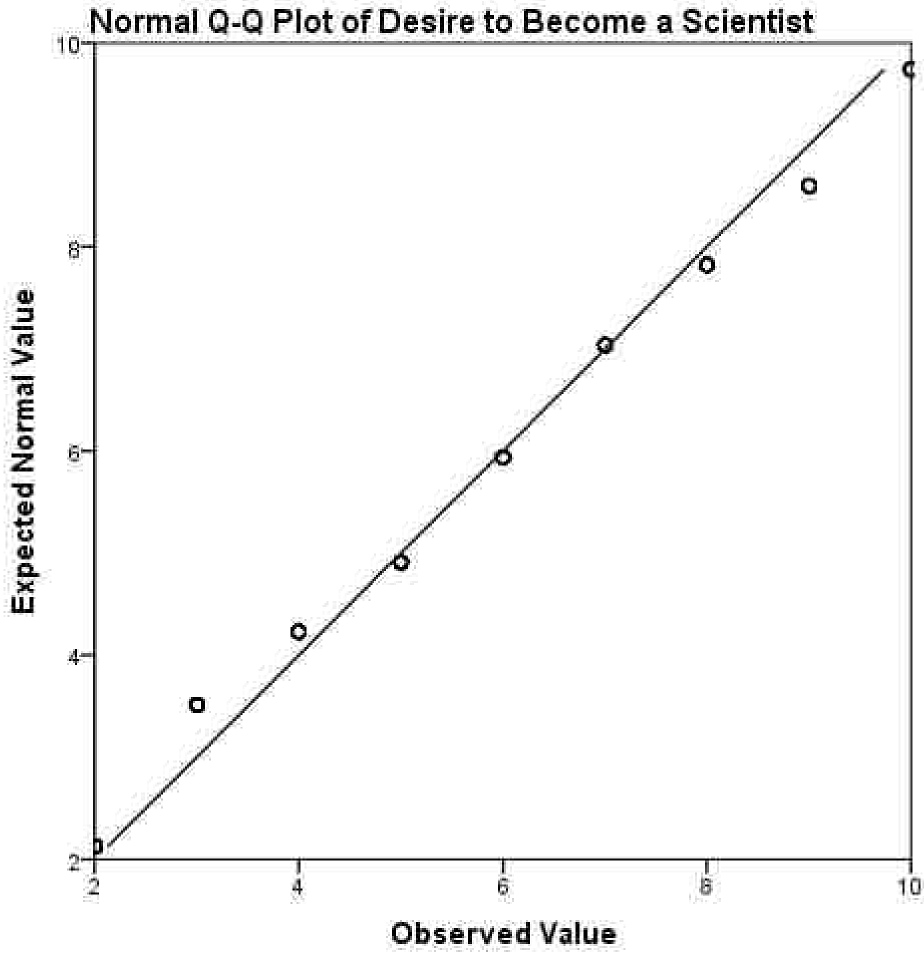

Figure 10. QQ Plot for Desire to Become a Scientist of Male and Female Middle School Students

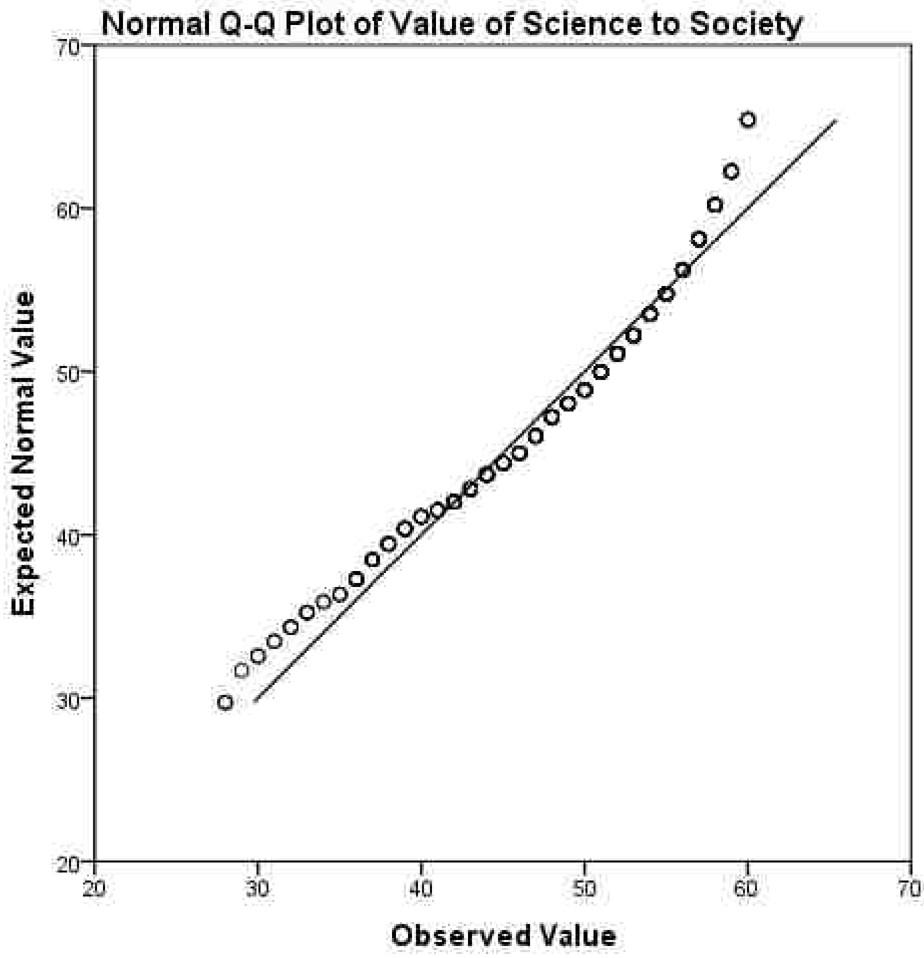

Figure 11. QQ Plot for Value of Science to Society of Male and Female Middle School Students

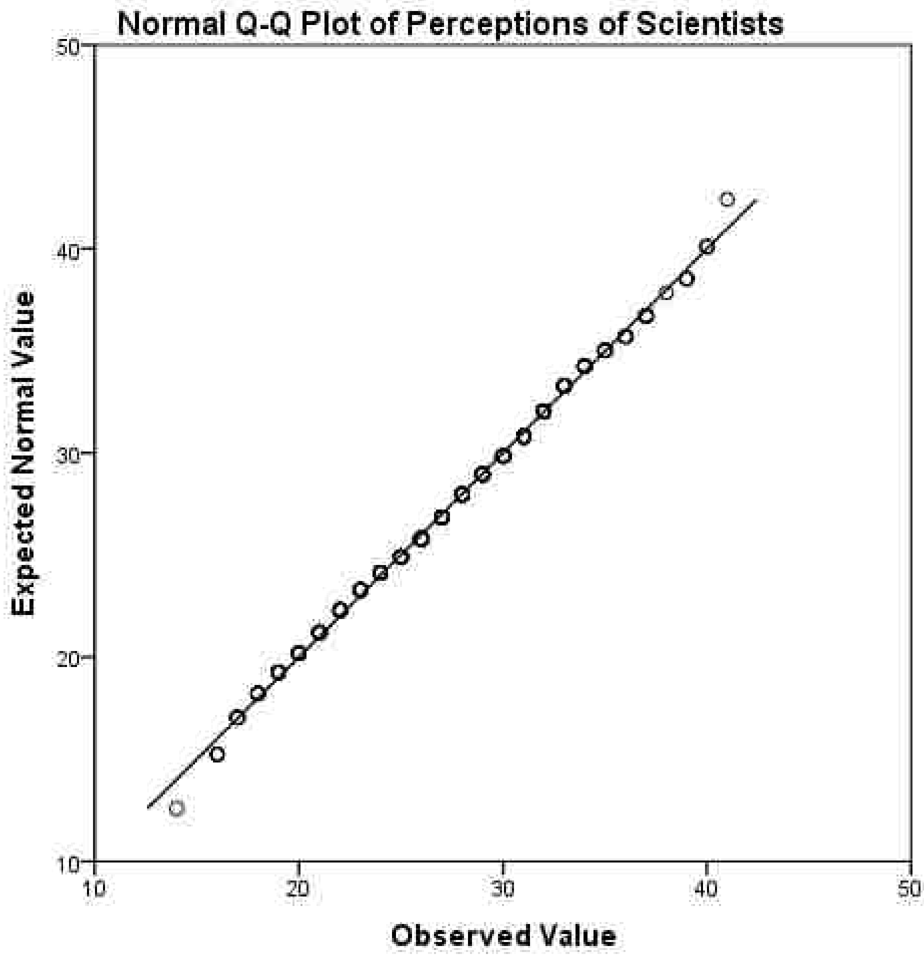

Figure 12. QQ Plot for Perceptions of Scientists of Male and Female Middle School Students

The Box's M test was used to test the equality of covariance matrices. The assumption of covariance matrices was met (p = .467).

Analysis

A one-way MANOVA was conducted to determine if there was a difference in attitudes towards school science, desire to become a scientist, value of science to society, and perceptions of scientists of male and female middle school students. A Wilks' Lambda statistic was used. The result of the MANOVA was not significant at an alpha level of .05, where $F(4, 445) = 1.96$, $p = .10$, partial $\eta^2 = 0.02$, suggesting there was no significant differences in male and female middle school students' attitudes toward school science, desire to become a scientist, value of science to society, and perceptions of scientists. The effect size as measured by partial eta squared was small. Therefore, the null hypothesis failed to be rejected deeming post hoc analyses unnecessary.

Additional Analysis

Cronbach's alpha coefficients were calculated to assess the internal consistency of each of the four attitude subscales. Analysis of these coefficients showed internal consistency for three of the four subscales. The Cronbach's alpha coefficients for the attitude toward school science, desire to become a scientist, and value of science to society subscales were found to be .893, .774, and .781 respectively. The perception of scientists subscale showed a lower coefficient (.534) which is very similar the coefficient calculated by the instrument developers. Hillman et al. (2016) explained this lower coefficient could be due to a change in what stereotypical traits children ascribe to scientists.

CHAPTER FIVE: CONCLUSIONS

Overview

This chapter will provide a discussion of the results, comparing and contrasting the findings with those of previous researchers. Implications of the findings will be discussed. Limitations of the present study will be provided, and recommendations for future research will be offered.

Discussion

The purpose of this study was to compare middle school students' attitudes toward science based on biological sex. Men often outnumber women in scientific careers, a phenomenon referred to as the gender gap. This inequity has maintained the interest of educational researchers for more than four decades. Recent research, however, suggests the gender gap could be closing as more and more women enter science professions (Farland-Smith, 2009; Jones et al., 2000; Wang & Degol, 2017). Students' attitudes toward science, which influences their career choices, can be divided into four domains: attitudes toward school science, desire to become scientists, value of science to society, and perceptions of scientists. The goal of this study was to examine middle school students' attitudes toward science across these domains to determine whether or not the gender gap still exists in classrooms.

The research question for this study asked, "To what extent do attitudes toward school science, desire to become a scientist, value of science to society, and perceptions of scientists of male and female middle school students differ as measured by the My Attitudes Toward Science (MATS) instrument?" The results of this study indicated that male and female middle school students' attitudes toward science are not significantly different. A comparison across each attitude domain measured by the MATS instrument revealed similar scores for males and females. Overall, the attitudes toward school science of male (*M* = 56.07, *SD* = 9.70) and female (*M* = 54.04, *SD* = 10.84) middle school students was positive. The students' desire to become scientists was almost neutral for both males (*M* = 5.49, *SD* = 2.28) and females (*M* = 5.17, *SD* = 2.34). Male (*M* = 48.15, *SD* = 7.28) and female (*M* = 48.52, *SD* = 6.65) students also shared positive views of the value of science to society. Finally, male (*M* = 27.56, *SD* = 5.16) and female (*M* = 27.47, *SD* = 4.86) students indicated a low ideation of scientist stereotypes. These results are in agreement with the findings of several recent studies (Desy et al., 2011; George, 2003, 2006; Gokhale et al., 2015; Shah et al., 2013).

The attitudinal pathway model (2002) developed by Liben and Bigler (2006) can be used to help explain the impact gender stereotypes have on other domains of students' attitudes. This pathway model is based on students' endorsements of gender stereotypes (Weisgram & Bigler, 2006). According to the attitudinal pathway model, students who endorse gender stereotypes are less likely to engage in activities aligned with the opposite sex (Weisgram & Bigler, 2006). The results of this study show that neither male (*M* = 27.56, *SD* = 5.16) nor female (*M* = 27.47, *SD* = 4.86) middle school students highly endorse stereotypical scientist traits, which includes the idea that science is a male domain. According to the model, it would follow that students of both biological sexes should then be more willing to participate in science activities. The male (*M* = 56.07, *SD* = 9.70) and female (*M* = 54.04, *SD* = 10.84) students involved in this study did show a greater appreciation for science in school. The male (*M* = 48.15, *SD* = 7.28) and female (*M* = 48.52, *SD* = 6.65) students in this study also consider science to be a valuable part of society. Similarly, there was no significant difference found in male (*M* = 5.49, *SD* = 2.28) and female

(M = 5.17, SD = 2.34) students' desire for careers in science. This result is also supported by Liben and Bigler's model.

Shah, Mahood, and Harrison (2013) experienced a similar finding to the present study by documenting an increase in female students' attitudes toward school science. The authors suggested their result may have been due, in part, to female students' strong work ethic while attending school in Pakistan (Shah et al., 2013). Results of the present study may indicate this trend is more generalizable than Shah et al. originally thought. Female students in the United States are also experiencing a favorable shift in attitudes toward school science. The positive change may be due to the numerous curricular reforms and interventions introduced within American school systems.

The results of the present study are inconsistent with the findings of Smith et al. (2014) and Naizer et al. (2014). In their studies, female students were found to show less interest in science than male students (Naizer et al., 2014; Smith et al., 2014). Their results may have been different from those in the present study because their studies included an achievement component and measured changes in attitude over time. Naizer et al. explained that female students show a decline in confidence in science which becomes most pronounced by the time the students reach 17 years of age. The results of this study, however, measured students' attitudes toward science at one point in time and may have been more consistent with the findings of Naizer et al. had the study been longitudinal.

Desy et al. (2011) indicated that female middle school students were very interested in scientific careers, while the present study demonstrated a more neutral desire for students to become future scientists. The literature showed there was no specific link between students' attitudes toward other areas of science and their desire to become scientists. Jenkins and Nelson

(2005) suggest this lack of correlation may be due to students not understanding what science careers exist. Desy et al. also explained that students planning to enter healthcare professions may not realize they are actually working in scientific career fields. Students may indicate they are uninterested in science careers on the MATS and similar surveys though they plan to become healthcare providers simply because they do not recognize medicine as a scientific field.

Like the present study, studies by George (2003, 2006) revealed that middle school students have positive views of science within their lives. Desy et al. also showed the positive views of students toward the value of science, though their attitudes toward science in school remained low. The findings of the present study, however, document positive views toward the value of science as well as studying science in school. Desy et al.'s finding may demonstrate that students in current middle schools recognize the value of science regardless of their feelings toward studying science in school.

Unlike previous studies, Gokhale et al. (2015) observed a shift in the stereotypical beliefs held by both male and female students. Students of both biological sexes were observed to be more accepting of non-traditional roles for the opposite sex (Gokhale et al., 2015). The change seen in Gokhale et al.'s study appears to have continued in the present study. Members of both biological sexes indicated a lower stereotypical ideation of scientists through the MATS instrument suggesting the belief that science is a male domain may be waning. Gokhale et al.'s finding, continued in this study, may represent a hope for a cultural shift in acceptance of non-traditional gender roles.

Implications

The results of this study suggest there are no real differences in middle school students' attitudes toward science based on biological sex. Literature spanning several decades exists documenting a gender gap in science in science attitudes and achievement. This study adds to the body of knowledge, along with several other studies, to show a change in the gap that previously existed. Students appear to have more positive attitudes toward science in school and better recognize its value in society regardless of biological sex. The students surveyed also demonstrated a change in their perceptions of what it means to be a scientist. Interventions and recent reform in science curriculum could be having a positive effect on students' attitudes toward science. The only change that seems to be unaffected is the students' desire to become scientists. Neither male nor female students indicated a great desire to become scientists, regardless of positive attitudes in the other three attitude domains. This finding supports the work of previous researchers (Jenkins & Nelson, 2005; Un-Nisa et al., 2011) who found students of both biological sexes losing interest in entering science professions. Some countries are already having a difficult time recruiting young men and women to become scientists (Jenkins & Nelson, 2005; Un-Nisa et al., 2011). Wang et al. (2017) suggest young men and women are losing confidence in themselves due to their own low perceptions of their scientific competence. If young men and women believe they are not competent in science, they will be less likely to pursue a career in a science-related field (Wang et al., 2017). Change may still need to come in order to recruit more students to enter science career fields.

Limitations

The sample used in this study was drawn from middle schools residing within the same district which could limit the generalizability of the results. It could be students from this particular school district do not share the same attitudes with other middle school students because of specific teaching strategies, curricula, or individuals employed by the district. Though 36 classes of students were recruited, only about one-third of the students actually participated. The students who did participate were required to bring home, sign, and return the consent forms. The remaining students may have forgotten to return the consent forms or explicitly chosen not to participate. The results from the students who did participate may be more positive than the views that could have been reported by the students who were unable to participate. Additionally, the numbers of male and female students used in the study were not equivalent, nor were the numbers of students in each of the three grade levels equivalent.

The normality violation represents a limitation to the study. Though the researcher used various methods to assess normality in an effort to proceed with analysis, the Kolmogorov-Smirnov test did reveal a violation. This violation may have had an impact of the overall findings.

The MATS instrument also represents a limitation. It is a relatively new instrument, and it yielded a low Cronbach's alpha for the perceptions of scientists subscale during its field testing. A similarly low Cronbach's alpha was calculated for this subscale during the present study. Therefore, the items on this subscale may not fully capture the intended attitude domain.

Recommendations for Future Research

1. Compare students' attitudes toward school science, desire to become a scientist, value of science to society, and perceptions of scientists in a longitudinal study to document students' attitude changes over time.
2. Compare students' attitudes toward science across these four attitude domains in other geographical locations to determine if the positive changes are widely occurring.
3. Compare students' attitudes toward science across these four attitude domains in a high school setting to determine if age 17 is a pivotal age for students' loss of interest in science as previous research suggests.

4. Compare students' attitudes toward science across these four attitude domains based on race and ethnicity rather than biological sex.
5. A future study may also be used to redevelop the MATS instrument. The final subscale pertaining to students' perceptions of scientists may need to be reworked or removed completely before using the instrument again in a middle school population.

Summary

This chapter has provided a discussion of the results, placing the findings in the context of extent literature. The implications of the study have been discussed, and the limitations were provided. The researcher also recommended ways for future studies to build on the findings of this study. Students in this study appear to be more positive to science in school and as a value to society, but they are still relatively uninterested in pursuing scientific careers. Finally, the middle school students in this study endorse low stereotypical perceptions of scientists. It will be important for future studies to continue to use specific attitude domains when comparing students' attitudes toward science.

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Appendix A

Permission to Use the MATS Instrument

Sent: Sunday, May 22, 2016 5:08 PM
To: Michelle Schpakow
Subject: Re: MATS instrument

Dear Michelle:

You have my permission with of course the caveat to always cite it in any presentation, publication, or public forum or circulation at all.

Thanks so much and good luck!

Appendix B

IRB Approval

LIBERTY UNIVERSITY.
INSTITUTIONAL REVIEW BOARD

December 7, 2017

Michelle L. Schpakow
IRB Approval 3062.120717: Attitudes of Male and Female Middle School Students toward Science

Dear Michelle L. Schpakow,

We are pleased to inform you that your study has been approved by the Liberty University IRB. This approval is extended to you for one year from the date provided above with your protocol number. If data collection proceeds past one year, or if you make changes in the methodology as it pertains to human subjects, you must submit an appropriate update form to the IRB. The forms for these cases were attached to your approval email.

Thank you for your cooperation with the IRB, and we wish you well with your research project.

Sincerely,

[redacted]

Administrative Chair of Institutional Research
The Graduate School

LIBERTY
UNIVERSITY.
Liberty University | Training Champions for Christ since 1971

Appendix C

Consent Form

The Liberty University Institutional
Review Board has approved
this document for use from
12/7/2017 to 12/6/2018
Protocol # 3062.120717

PARENT/GUARDIAN CONSENT FORM

Attitudes of Male and Female Middle School Students toward Science
Michelle L. Schpakow
Liberty University
School of Education

Your child is invited to be in a research study on attitudes of middle school students toward science. This study is to investigate how boys and girls feel about science in middle school. Your child was selected as a possible participant because he or she takes a general education science class in grade 6, 7, or 8. Please read this form and ask any questions you may have before agreeing to allow him or her to be in the study.

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

Background Information: The purpose of this study is to determine what, if any, differences exist in middle school students' attitudes toward school science, desire to become scientists, value of science to society, and perceptions of scientists based on biological sex.

Procedures: If you agree to allow your child to be in this study, I would ask him or her to do the following things:

1. Anonymously complete a 40 item multiple choice survey during his or her regularly scheduled science class period. The survey should take roughly 15 minutes to complete.

Risks: The risks involved in this study are minimal, which means they are equal to the risks your child would encounter in everyday life.

Benefits: Participants should not expect to receive a direct benefit from taking part in this study.

Compensation: Your child will be allowed to keep a pencil as a thank you for taking the survey.

Confidentiality: The records of this study will be kept private. In any sort of report I might publish, I will not include any information that will make it possible to identify a subject. Research records will be stored securely and only the researcher will have access to the records.

- The survey will not include names of participating students. Additionally, the students will seal their surveys within individual envelopes before they are collected to make sure they cannot be identified.
- Data will be stored on a password locked computer and may be used in future presentations. Survey answer sheets will be locked away in a cabinet. After three years, all electronic records will be deleted and survey answer sheets will be shredded.

Voluntary Nature of the Study: Participation in this study is voluntary. Your decision whether or not to allow your child to participate will not affect his or her current or future relations with Liberty University or Old Bridge Township School District. If you decide to allow your child to participate, he or she is free to not answer any question or to stop taking the survey at any time before turning in the survey without affecting those relationships.

The Liberty University Institutional
Review Board has approved
this document for use from
12/7/2017 to 12/6/2018
Protocol # 3062.120717

How to Withdraw from the Study: If your child chooses to withdraw from the study, your child should inform the researcher that he or she wishes to discontinue participation prior to submitting the study materials. Your child's responses will not be recorded or included in the study.

Contacts and Questions: The researcher conducting this study is Michelle L. Schpakow. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact her at mschpakow@liberty.edu. You may also contact the researcher's faculty advisor, Dr. Kurt Y. Michael, at kmichael9@liberty.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Institutional Review Board, 1971 University Blvd, Green Hall 1887, Lynchburg, VA 24515 or email at irb@liberty.edu.

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

Statement of Consent: I have read and understood the above information. I have asked questions and have received answers. I consent to allow my child to participate in the study.

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

____
Signature of Student Date

____
Signature of Parent Date

____
Signature of Investigator Date

Appendix D

Superintendent Agreement

Begin forwarded message:

From: [redacted]
Date: January 9, 2017 at 10:00:24 AM EST
To: Michelle Schpakow <mpatullo@obps.org>
Cc: [redacted]
Subject: RE: research participants

Michelle:

With agreement to prescreen questions, parent and building level consent, you have my approval.

Be well and be kind,
[redacted]
Superintendent of Schools
[redacted] – Local Pride & Global Impact

Appendix E

Verbal Instructions to be Read to Recruit Student Participants

(Read to class.)

Dear students,

Mrs. Michelle Schpakow from the School of Education at Liberty University is conducting a research study as part of the requirements for a doctoral degree. The study is to investigate how middle school students feel about science. The survey should only take about 15 minutes of your time. Your answers will be completely anonymous. Completing this survey is voluntary and will not affect your grade in any way. The results of this survey will be used to help educators better understand students' attitudes toward science, and as a result, will help other students in the future.

I will now distribute the survey to you along with an envelope and a pencil. You may keep the pencil as a thank you for your participation in this research. Do not begin until I tell you to do so.

(Distribute survey, pencils, and envelopes.)

Please look at the survey form with me. I want to review the two sections with you before you begin. The survey has two parts: Demographic Information and the My Attitudes Toward Science Survey. Look at Part I: Demographic Information. Mark the box or fill in the blank with the answer that best describes you. Look at Part II: My Attitudes Toward Science Survey. Rate how strongly you agree or disagree with each of the statements by marking the appropriate circle.

You may quit the survey at any time by simply writing on the questionnaire "Stop" or "I do not wish to participate." Upon completion, please place your survey into the envelope, seal it, and wait for me to collect it from you.

Do you have any questions before you begin? **(Pause to address questions.)** *You may begin.*

(Collect the sealed envelopes from the students at the end of the survey.)