

A Dissertation

entitled

Gender Differences in Math and Science Choices and Preferences

by

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Submitted to the Graduate Faculty as partial fulfillment of the requirements for the

Doctor of Philosophy Degree in Curriculum and Instruction

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The purpose of this dissertation is to discover how the myth of gender differences in STEM inform the lived experiences of male and female 12<sup>th</sup> graders in one high school in Northwest Ohio. Over the years, the observed gender gap favoring males over females in STEM ability has closed, and female students have even surpassed males in some measures. The fact that girls have met and exceeded boys in many measures of STEM ability over time suggests that the historical disparity was the result of social or psychological, and not biological, differences. Even though schools have changed throughout the years to accommodate and encourage female students in STEM, there is still a persistent disparity in participation at the highest levels of STEM in education and in careers. Males still outnumber females in the more mathematical and technical sciences, such as computer science and engineering. This study applied feminist socialization theory and phenomenology as its theoretical framework. The biggest themes that informed student's choices and preferences were as follows: intended choices follow family influence, myth persists in subtle ways, teenagers have a limited future view, and the chicken and the egg issues of personal interests versus social influence. There are

clearly more factors that contribute to this gender socialization, which may be a combination of socioeconomic status and the influence of family.

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## Chapter One

### Introduction

This chapter provides a brief overview of the problem of gender differences in science, technology, engineering, and mathematics (STEM) course preferences and provides a few useful key terms.

### **Background of the Problem**

The following sources about historical trends and international evidence show that the gender gap in measures of STEM ability and achievements has narrowed and nearly disappeared as educational opportunities for women increased. Researchers such as Meece and Courtney (1992) and Mickelson (1989) began to observe this phenomenon in the late 1980s and early 1990s. In a review of the empirical evidence from 1980 to 1990, Meece and Courtney observed that the gender gap related to STEM had narrowed significantly throughout that decade. Similarly, Adelman (1991) analyzed data from the National Longitudinal Study (NLS), finding in overall high school coursework completed, female STEM academic achievements equal males. Some slight differences were still observed in high-stakes test scores, such as the National Educational Longitudinal Study of 1988 from Grades 8–12 that showed a slight difference in math scores favoring boys, although the researchers noted the effect sizes were small (Fan, Chen, & Matsumoto, 1997).

Despite the parity achieved during this time period, gender gaps persisted in terms of enrollment in specific courses and majors, with females enrolling in significantly fewer high-level mathematics, science, and computer courses (Bussey & Bandura, 1999). Likewise, based on national and international data of the types of classes students register

for in high school and college, evidence showed a significant difference between the scientific subjects boys and girls preferred (Kenway & Gough, 1998). While the total number of males and females in science majors was nearly equal, the specific field within science still differed significantly: males took engineering, computer science, and physical sciences in higher numbers, while more females took biology, chemistry, and psychology (American Association of University Women Educational Foundation [AAUWEF], 1998; Kenway and Gough, 1998). Marion and Coladarci (1993) categorized the particular subjects males were more likely to major in these fields as mathematics and quantitatively oriented sciences, but many others refer to these courses as STEM courses (science, technology, engineering, and mathematics).

Recent research from the 2000s showed the trend has plateaued: female students still demonstrate equal intelligence, ability, and grades in STEM (Coley, 2001), but still do not take as many high-level and quantitatively oriented STEM courses late in high school and throughout college and struggle with high-stakes tests in these fields (Amelink, 2009). In a summary of 25 years of evidence from 1980-2005, Jacobs (2005) concluded girls have achieved increasing success in and/or a stronger identification in STEM courses. At the same time, current research has supported earlier evidence showing even when the total number of science courses taken by males and females was similar, the types of courses differed (Coley, 2001; National Science Foundation, 2008; Amelink 2009).

For example, evidence concerning science courses has shown that in all racial/ethnic groups, females have made significant progress in academic achievement over the decade (Coley, 2001), but still major in different types of science courses. Based

on national and international data of the types of classes students register for in high school and college, evidence showed a significant difference between which scientific subjects boys and girls have preferred (Kenway & Gough, 1998; Coley, 2001; Amelink, 2009). Female students also still struggle with STEM areas of high-stakes tests (Santrock, 2008). According to the American College Test (ACT) High School Profile Report (2007), fewer females demonstrated readiness for college-level science coursework than males. Additionally, male high schools students have scored higher on AP subject tests than females (Assessing Women and Men in Engineering [AWE], 2009), and Coley (2001) found males scored higher than females on the National Assessment of Educational Progress (NAEP) as well.

### **Summary of the Background**

Because of the changes in gender differences over time, the evidence overwhelmingly suggests gender differences in STEM that existed historically and those that still persist today are based on psycho-social rather than biological factors; i.e., they are learned behaviors. Despite achieving parity in grades and most other measures of achievement, girls tend to perform worse on high-stakes and standardized tests in science and in most cases boys perform better on science tests. These differences include a slight disparity in test scores, especially at the highest levels, and a major difference in enrollment numbers in certain science and math courses. Both these differences appear to become greater as boys and girls grow older, from 8th to 12th grade and beyond into higher education.

Upon closer inspection within the science and math fields, differences emerge in terms of which field within science and math males and females pursue in their education and careers. So although nearly as many females took science and math courses as males,

the male students enrolled in the more mathematically and quantitatively demanding STEM courses. Again, the degrees males achieve more than females tends to have a heavier mathematics and quantitative focus. Taken together, the fact that females show equal ability and intelligence in STEM but differ only in high-stakes testing and the course and career choices at the highest levels suggests these persistent differences are related to interactions between the individual and his/her social environment rather than innate qualities.

### **Statement of the Problem**

The fact that girls have met and exceeded boys in many measures of STEM ability over time suggests that the historical disparity was the result of social or psychological, and not biological, differences. However, even with increased parity, female students tend to perform worse on high-stakes tests and largely shy away from the most demanding STEM courses and careers. The underlying factors appear to be psycho-social in nature, specifically relating to self-perceptions, social expectations, and learning environment preferences.

Girls' self-perceptions of STEM ability are still below boys'. Despite the lack of gender differences in intelligence, boys and girls judge their capabilities in these academic domains differently (Benbow & Stanley, 1980). Bussey and Bandura (1999) argue that the differential precollege preparation stems from differences in support and encouragement from teachers, peers, and parents to pursue quantitative and scientific coursework, not from differences in ability. Bussey and Bandura (1999) cited that the gap

in the perceived ability and self-efficacy grows as boys and girls age, with girls beginning to lose confidence in their math abilities relative to boys as they move into high school.

While the perceived STEM self-efficacy of female students tends to be below male students, girls have higher perceived efficacy and valuation of mathematics in classrooms where teachers emphasize the usefulness of quantitative skills, encourage cooperative rather than competitive learning, and minimize social comparisons of ability (Eccles, 1989). Additionally, according to Santrock (2008), girls' science test scores improved in science classes that emphasized hands-on lab activities. Overall, female students appear to perform better in more cooperative and less competitive learning environments (Bussey & Bandura, 1999).

Similar to the problem competitive learning environments causes for female students, high-stakes testing also appears to not be a conducive assessment format for many female students. Hannon (2012) argued that the test anxiety and performance avoidance goals accounted for all of the gender differences in SAT scores and overall SAT performance as a result of social/learning factors. Two social/personality factors which appear to influence this phenomenon: correlations indicate that females experience more test anxiety and have higher performance-avoidance goals (Hannnon, 2012). The results revealed that each social /personality factor accounted for all of the significant gender differences in SAT-V, SAT-M, and overall SAT.

Moreover, as Bussey and Bandura (1999) note, a difference exists in these courses between the amount of competitiveness versus cooperation promoted, how much hands-on activities are incorporated, and the emphasis on usefulness for society, with female students tending to prefer those courses that promote more cooperativeness, hands-on



work, and usefulness. Based on the literature, those learning environments that are more supportive and cooperative as well as hands-on tend to appeal to females students.

Moreover, the competitiveness of high-stakes testing and certain STEM courses tends to discourage female students. In order to understand psycho-social factors influencing course selection and learning environment/testing preferences, it is beneficial to explore the beliefs about STEM gender differences held by male and female high school students at the junior and senior levels as they begin to consider their college and career choices.

### **Significance of the Problem**

This topic is important because even though no cognitive or biological differences exist, environmental and social gender differences persist in areas such as choices of majors and career paths. Moreover, the myth that there are gender differences in STEM might still inform the lived experiences and perspectives of male and female high school students and their intended choices. Knowing the degree to which the myths about gender persist in today's youth can help determine how much work is still needed to counteract the myths.

This research will highlight lived experiences about gender differences in science and math education, bringing the educational community closer to understanding this phenomenon. My study will contribute to the field of Curriculum and Instruction by determining to what extent more effort is needed in the education system to dispel gender myths and remove perceived boundaries within certain science and math career paths. Subsequently, this study could lead to the incorporation of teaching strategies to challenge persistent myths and perceived obstacles.

Ultimately, the goal of education should be that both genders will feel they can follow their interests and career goals without believing they are different or that the opportunities differ between males and females. Male and female students' choices of STEM courses and choices of a future career in math or science should be based on their interests and abilities with as much personal agency and as few unnecessary obstacles as possible. If this study determines 11th and 12th grade male and female students have strong beliefs about the existence of gender differences individually and socially, then it would point to the need to address these beliefs and dispel any persistent myths if necessary. Doing so could help empower male and female students to satisfy their educational and career desires.

### **Theoretical Framework: Feminist Socialization Theory and Phenomenology**

This dissertation is written within the feminist theory, which is a theory that critiques the definitions, roles, and conceptualization in gender in various ways. While a wide range of offshoots of feminist theory have formed, they all share a critical focus on questioning the meaning gender. In this dissertation, I analyzed and discuss my results within the feminist framework at the point at which two offshoots converge: feminist socialization theory and feminist phenomenology.

One of the perspectives within feminist theory is feminist socialization theory. This theory asserts that gender is socially constructed. Socialization theorists argue that when treated as rational and capable individuals, girls will prove themselves just as smart, independent, confident, and creative as boys (Thompson, 2003, p. 15). The main focus of socialization theory is how access to opportunities influences choices boys and girls make. Therefore, the goal of feminist socialization is to create equal opportunities

for both genders in which the individual can fulfill their potential based on individual capabilities rather than prescribed roles as much as possible.

Along with feminist socialization theory, I interpret my research within feminist phenomenology. Phenomenology is a perspective that all knowledge comes through lived experience and no knowledge exists outside of experience. It stems from the writings of Edmund Husserl (1937/1970), who was a male philosopher writing from the perspective of his own experience. Feminist phenomenologists such as Simone de Beauvoir and Judith Butler (1988) appreciated what Husserl argued, but because he wrote from his own male perspective and lived experience, they added their own feminist perspectives on phenomenology. For Butler, gender is a performative experience manifested as a series of acts that make up a performance, each act with varying degrees of adherence to a dominant script, from reification to subversion. Society provides the preexisting cloth of gender that the individual wears and has scripted the roles that the individual fulfills, but at the same time the individual has the ability to wear the clothes and perform the role in ways that can reinforce or challenge the dominant script.

### **Research Questions**

Based on the literature review, the theoretical framework, the purpose of the dissertation, and the results of the pilot study, the central research question is: What experiences do male and female 12<sup>th</sup> graders in two high schools in Northwest Ohio have with the myth of gender differences in STEM? This central research question is exploratory because the purpose is to investigate the essence of the experiences with the myth, which is open-ended and not very well known. This central research question branches into three sub-questions as follows:

- › 1. What do the male and female 12<sup>th</sup> grade students believe about the myth of gender differences in STEM?
- › 2. How do the male and female 12<sup>th</sup> grade students describe their experiences with the myth of gender differences in STEM?
- › 3. What are the similarities and differences in male and female students' experiences with the myth of gender differences in STEM ability?

These sub-questions are more descriptive in nature and help support the exploratory central research questions.

In the exploration of these research questions, the feminist phenomenological conceptual framework of (who and who) will provide the lens through which I will interpret the essence of the lived experiences.

### **Definition of Terms**

***Gender:*** Gender is the socially constructed corollary to biologically determined physical expressions of sex. Gender conceptions and role behaviors are the products of a broad network of social influences such as family and the many societal systems encountered in everyday life, with underlying biological constraints. Together, these form the various gendered acts and performances of individuals (Butler, 1988).

***Preferences:*** The tendencies one has towards enjoying certain activities, topics, subject areas, environments, etc., while disliking others.

***Agency:*** Individuals have influence and control to a certain extent over their lives, preferences, and decisions in a purposeful, goal-directed fashion (Bandura, 2001).

## **Organization of Dissertation**

Here in Chapter 1, I have presented a brief introduction to the topic, problem, purpose, research questions, theoretical framework, and definitions that concern the issue of lived experiences about gender differences in STEM among 11<sup>th</sup> and 12<sup>th</sup> grade students in Northwest Ohio.

Chapter 2 reviews the current literature on gender differences in STEM courses. The literature review reports findings on gender differences in STEM throughout history and between cultures before focusing on the current state in the US. The subtopics explored include differences in grades, test scores, course preferences, college major enrollment, and career choices. The review summarizes the findings on various proposed reasons for the observed differences, including biological, environmental, and personal factors.

Chapter 3 describes the previous research questions, hypotheses, and methods conducted in a two-part pilot study. These pilot studies revealed weaknesses in the validity and reliability of the questionnaire. Moreover, the findings led to changes in the theoretical framework. Thus, Chapter 3 explains how the findings from the two parts of the pilot study led to the current framework and methods.

Chapter 4 provides an in-depth explanation of the feminist theory framework. Feminist theory is complex and potentially controversial, so it needs its own chapter to present and explain for the reader. Moreover, Chapter 4 explains how the feminist perspective portrays and interprets gender differences in STEM.

Chapter 5 explains the methodology which will be used in this study. The methodology will be based on a qualitative approach called phenomenology. The

qualitative data will be collected via interviews. The ATLAS.ti computer programs will be used to analyze the qualitative data respectively, and Chapter 5 explains how they will be used in greater detail.

Chapter 6 will report the results of the data. It will present a summary of the qualitative findings with descriptions of the participants and the most important quotes from their interviews. The demographics, types of schools, highest level STEM courses, and important excerpts from the interviews will all be reported.

The results of the interview will be explored and discussed in greater depth in Chapter 7, which will connect the findings to larger themes that tie the interview results together in the context of current literature and the feminist framework. The synthesis of all the findings in relation to the current literature and the feminist framework will help answer the third research question.

### **Summary**

While no significant gender differences exist in STEM intelligence and ability, differences in courses and careers chosen at the higher levels of education persist. Moreover, gender differences in STEM preferences and perceptions of self-efficacy persist. The current research proposes to gather the beliefs and lived experiences about gender differences in STEM held by male and female 12<sup>th</sup> graders using interviews and to explore through a feminist perspective how gender issues that inform their beliefs and lived experiences.

## Chapter Two

### Literature Review

Over the years, the observed gender gap favoring males over females in STEM ability has closed, and female students have even surpassed males in some measures. While the gap does persist in some parts of the world, these gaps are attributable to differences in access to education and academic advancement in these subjects. In the U.S., the gender gap in STEM as measured by standardized test scores and grades was noted to have closed by as early as the 1980s (Mickelson, 1989). Analyzing the National Educational Longitudinal Study (NELS) of 1988 with data from students from grades 8-12, Fan, Chen, and Matsumoto (1997) found that while the data showed boys' math scores were slightly higher, the effect sizes were small. Throughout the past 25 years, girls have achieved increasing success in such subjects (Jacobs, 2005). Because of the changes in gender differences over time, it is clear that gender differences in STEM are based on social factors. However, some interesting gender differences still persist in relation to perceptions of self and in choices made at higher levels of educational and career tracks in the science and math fields.

#### **Historical Gender Gap Has Closed**

Currently, research shows there is no difference between males and females in terms of intelligence and ability in science. Matthews, Pontiz, and Morrison (2009) found that no significant gender differences were found on five academic outcomes as measured by the Woodcock–Johnson III Tests of Achievement. The ability and intelligence of males and females in science subjects show little to no difference (Jacobs, 2005; Mickelson, 1989).

Likewise, no difference exists between males and females in math intelligence and ability. Hyde, Fennema, and Lamon (1990) found that gender differences in math performance are small. Fan, Chen, and Matsumoto (1997) reported that gender differences in the NELS 1988 study were not founded in math when total-group was adjusted for gender imbalance by region, socioeconomic status, and race.

### **Cross-Cultural Differences**

In cross cultural comparison, differences between males and females exist in some parts of the world and in certain subgroups in the U.S. Data from Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA) have shown a wide range in cross-national variability in gender gaps in STEM (Else-Quest, Hyde, & Linn, 2010). Gender equity was the most power predictor for these persistent differences, in terms of female school enrollment numbers, women's share of research jobs, and women's parliamentary representation. Kane and Mertz (2012) found no correlation between countries' effect sizes in mean math performance on 2009 PISA and their 2009 GGIs. The gap was either not significantly different from zero or favored boys for all predominantly Muslim countries.

### **Performance**

There appears to be no differences in performance between boys and girls, males perform slightly better on the construct of science and had more accurate performance, more self-efficacy and performed better on science tests. Ding (2006) found there were no significant differences in the growth rate in math performance for both males and females. Hyde, Fennema, and Lamon (1990) did find females outperformed males, but



only by a negligible amount. Jacobs, Lanza, Osgood, Eccles, and Wigfield (2002) focused on the domain-specific self-competence beliefs and domain-specific motivation and performance reported that when children believe that they have the ability to accomplish a particular task, they perform better and are more motivated to select increasingly challenging tasks.

Differences in performance emerge when one takes a closer look at different domains. Kiran and Sungur (2012) found that females performed better than males on the social aspects of science factors and males tended to perform better than females on the constructs of science factors, although no consistent gender difference was noted for items dealing with life science. With respect to the abilities necessary to do scientific inquiry factor, females tended to perform better than males in 9th and 10th grades while no consistent gender difference was observed in Grade 11.

### **Classroom Achievement**

Math and science achievement in school is frequently measured by either grades or test scores, and the gender differences between these two measures are interesting. While girls and boys are similar in achievement, girls have higher GPAs in STEM while boys have higher test scores (Britner, 2007; Santrock, 2008; Saunders, Davis, Williams, & Williams, 2004).

Mickelson (1989) and O'Reilly and McNamara (2007) found that women achieve as well as men in academic achievement, including in science. However, Ormrod (2007) claimed that while boys and girls achieve similar results on general intelligence tests, in most cases boys perform better on science tests. Freedman (2001) cited that female and

male students within the treatment group did not differ significantly on the objective examination of achievement in science knowledge.

Van de gaer, Pusjens, Damme, and De Munter (2008) found that there were gender differences in math participation and in math achievement across secondary school, but the differences shifted over time: At the beginning of school in math achievement boys scored significantly higher than girls, but the gap closes and girls even surpass boys at higher grade levels.

Haussler and Hoffmann (2002) found an intervention that adapted the curriculum to the interests of girls and which promoted the ability of girls resulted in improved immediate and long-term achievements for both boys and girls among German students. Cunningham (2007) found extracurricular and informal learning experiences, including participation in science competitions or science-related field trips, promotes females' science achievement and interest in engineering.

### **Grade Differences**

Evidence shows grade differences are not significantly different. If anything, girls have slightly higher STEM GPAs than boys. Even as early as the 1990s, the average grades of women were about equal to or slightly higher than men's average grades (Bridgemaana & Wendler, 1991). Jacob (2005) found evidence of differences in grades is generally weak and show the gender gap has closed. The AAUWEF (1998) found that girls actually achieve higher grades than boys in science. Britner (2007) also found that girls in life science class earned higher grades than boys. Saunders, Davis, Williams, and Williams (2004) found females' math GPA was significantly higher than males. Interestingly, some changes in grade differences emerge as students mature. Females

have been shown to have a higher math GPA than males during the middle school years and high school years (Amelink, 2009).

### **Test score Differences**

While girls have been shown to have equal or even slightly higher GPAs in STEM, boys are slightly higher in many high stakes tests on average and, in particular, appear to be overrepresented at the extreme tails. Santrock (2008) noted that boys scored higher than girls and on science tests in general, especially among average-and high-ability students. Bridgema and Wendler (1991) found that men's average scores on the math scale of the SAT were above women's average scores by a third of a standard deviation or more. Eccles (2005) reinforced this finding and showed the SAT gap still persists. However, Nature Neuroscience (2005) reported that boys are in "the tails in the curve. The worst performers and the highest scorers tend to be male" on the SAT (p. 253). According to ACT (2009) fewer females demonstrated readiness for college-level science coursework than males.

Boys did slightly better in science than girls in the 4th, 8th, and 12th grades on the NAEP (Santrock, 2008). Mau and Lynn (2000) cited that males are higher in mean math score than females. Male high schools students continue to take science AP subject tests at higher percentages than females. Beller and Gafni (1996) cited that the gender effect sizes on the math assessed at the subdomains level and the total scores were found to be small and observed that the total scores were found to be small and the gender effect in science was larger than those for math on the total score. Smyth and McArdie (2004) cited math scores were the same for ethnic group and gender group.

As a result of the challenge high-stakes testing seems to pose for girls, Sandler, Silverberg, and Hall (1996) claimed that assessments at the national level and employed in classrooms used to measure science achievement should be reviewed for gender bias given the reported trends associated with female achievement in high school science courses that is comparable to male counterparts. Instructional professionals, including administrators, should examine gender bias that may be inherent in science classrooms including teacher's attitudes, behaviors, and pedagogical strategies. Halpern, Benbow, Geary, Gur, Hyde, and Gernsbacher (2007) recommended that practitioners should consider using a variety of assessment methods to gauge student achievement in science so that they have a more complete picture of students' strengths and weaknesses.

### **Course Choices**

While the current disparity between males and females in science appears to be disappearing, a closer examination reveals certain persistent differences in course choices. There is no difference in the total number of STEM courses, but a difference exists in the specific type. Physics has the most significant gap. While in some science subjects females equal or even surpass males, in others they lag behind. On the promising side, a longitudinal study conducted by the National Center for Education Statistics reveals females are enrolling in more science courses in high school and are enrolling in advanced science courses at higher rates than males (i.e. Chemistry II, Physics II, and Advanced Biology) (Ingels & Dalton, 2008).

Likewise, Amelink (2009) found male and female respondents report taking approximately the same average years of study in the natural sciences. ETS (2001) found that in all racial/ethnic groups, females have made significant progress over the decade in

taking four years of science in high school. Duckworth and Seligman (2006) report girls are more concerned, engaged, and diligent students than males and are more likely to graduate from high school.

On the less promising side, within Advanced Placement (AP) high school courses, physics has the most significant gender gap, with boys taking it more than girls, both regular and AP courses; however in biology and chemistry, girls actually take the course more than boys (Amelink, 2009). Crombie et al.(2005) observed that boys pursue utility to enrollment intentions which are stronger than girls. Van de gaer, Pustlens, Van Damme, and De Munter(2008). Boys attach a higher value and utility to math for career choices and have higher self-concept in math explain why they choose to participate more in math than girls. The path for girls is directly from competence beliefs to enrollment intentions, even though girls & boys reported similar levels of math utility.

Although the evidence shows girls and boys take approximately the same number and types of science courses in high school, by college bigger differences emerge. Thomas, Hoffer Kennet, Rasinski (1995) said that males and females did not differ significantly in the numbers in STEM courses. Marion (1993) discovered that nearly as many females took science and math courses as males, the male students enrolled in the more mathematically and quantitatively demanding STEM courses. As the American Association of University Women Educational Foundation (AAUWEF) (1998) observed "a much discussed gap between girls and boys in the actual number of mathematics and science courses taken appears to be diminishing. But gender differences remain in the kinds of courses taken" (p. 1). Multiple studies over the past 10 years have observed that even when the overall number of males and females in science majors is nearly equal, the

specific field within science still differs significantly; males take engineering, computer science, and physical sciences in higher numbers, while more females take biology, chemistry, and psychology (AAUWEF, 1998; Kenway and Gough, 1998; Coley, 2001; National Science Foundation, 2008; Amelink 2009).

### **College Major Differences**

Males and females differ in specific choices of major, with males taking more quantitative and mathematical subjects and females more health and life science. Coley (2001), AAUWEF (1998), and Kenway and Gough (1998) found that while the number of males and females in science majors is nearly equal, the specific field within science still differs significantly. According to National Science Foundation (2008) and Marion (1993), males are more likely to major in mathematics and quantitatively oriented sciences and male students were enrolled in the more mathematically and quantitatively demanding STEM courses. Smyth and McArdle (2004) suggested that the implications for choosing colleges, choosing students, and for efforts is to improve precollege STEM preparation for all students. A primary effect of secondary school science instruction should be to help interested minority students to become qualified for SME majors in college.

As far as degrees achieved, males surpass females in number of undergraduate degrees awarded in science and engineering majors, computer science, physical science, and engineering show the greatest differences, while females attain more degrees in biology and psychology (AWE, 2009). The Association of Women and Men in Engineering (AWE) (2009) speculated the reason for the difference is that women appear

to prefer fields that address the human application of science, such as biology, life sciences, and psychology.

In addition to choices made in courses and majors, choices made for activities outside of school also appear to differ. Some evidence suggests females were less likely than males to participate in science activities outside the classes (Amelink, 2009). This lower level of participation may affect science interests and future participation in science fields.

Cunningham (2007) found extracurricular and informal learning experiences, including participation in science competitions or science-related field trips, promotes females' science achievement and interest in engineering. Amelink (2009) cited that the gender gap in science achievement may be narrowing as females are as likely to enroll in advanced science coursework as males at the pre-college level.

### **Career Differences**

The differences in course and major choices are reflected in career choices as well. Upon closer inspection within the science and math fields differences emerge in terms of which field within science and math, males and females pursue in their education and careers (Amelink, 2009). Science, technology, engineering, and mathematics (STEM) careers have significantly more males. Bauman, Sheri (2012) cited that the boys all aspired to stereotypically male jobs or gender-neutral jobs, and their choices were significantly different from what would be expected by chance. AWE (2009) observed that various possible reasons have been proposed for the persistence of such differences, especially in test scores, major, and career choices.

## **Reasons**

It becomes clear when looking at the literature that there are few if any differences between male and female students in intelligence, ability, testing, and classroom achievement in mathematics and science courses; however, college major and career choices differ. This raises the question of why the difference in careers persists. Fan (1988) claimed that the gender differences in the high end in math score disruption are likely to be one reason for gender imbalance in the flow into science and engineering careers. However, more recent literature has shown that the difference in high end math scores are not nearly as pronounced as the difference in career choices within those same fields. A more recent claim from Van de gaer, Pustlens, Van Damme, and De Munter (2008) asserted boys attach a higher value and utility to math for career choices and have higher self-concepts in math, which may explain why they choose to participate more in math than girls. Alternatively, Wang, Oliver, and Staver (2008) claimed that given the influence of parents' expectations for STEM education and STEM careers about future career aspirations among females, educators could inform and promote female students about career opportunities and role models in STEM fields, as well as the academic preparation needed to succeed in these fields. Overall, possible explanations for persistent college major and career differences between males and females include biological/sex factors, environmental/social factors, and personal/psychological factors.

### **Biology/Sex Factors**

While males and females differ biologically in terms of their body and physical ability, there are small differences in intellectually between men and women in genetic influence. According to Nature Neuroscience (2005), boys are in the tails in the curve,



meaning they are both the worst performers and the highest scorers. Baron-Cohen, Richler, Bisarya, Gurunathan, and Wheelwright (2003) explained the differences in the numbers of males and females at the highest levels of STEM in college and in STEM careers by a theory of cognitive differences called the Empathizing-Systematizing theory. They define empathizing as “the drive to identify another person’s emotions and thoughts, and to respond with the appropriate emotion” (p. 361), whereas Baron-Cohen (2009) defines systemizing as “the drive to analyze or construct systems” (p. 71). According to Baron-Cohen et al. (2003), females tend towards higher empathizing abilities while males tend towards higher systematizing abilities, leading to differing areas of interest. However, Baron-Cohen is one of the few researchers searching for biological factors of sex that affect gender differences in interest and abilities. Gabaccia and Maynes (2012) cited that in Germany there are no differences in the sex/gender distinguishing the indication of socially-constructed gender. The prevailing opinion of the biological influence on gender differences in STEM is that it “provides bodily structures and biological potentialities, not behavioral dictates” (Bussey & Bandura, 1999, p. 684). Instead, social and environmental factors seem to have a greater affect.

### **Social/Environmental Factors**

Santrock (2008) discovered that interactions between the child and social environment are the main keys to gender development and the differences that emerge based on gender. Social factors include social expectations, role models, curriculum design, family differences and parental influence, and peer influence.

**Social expectations.** Male dominant social expectations and stereotypes in science and math ability contribute to the persistent gender gap in participation and

performance. Santrock (2008) defined gender roles as the "social expectation that prescribe how males and females should think, act, and feel" (p. 165). Gender stereotypes are broad categories that reflect impressions and beliefs about what behavior is appropriate for females and males (p.167). Kiran and Sungur (2012) found females performed better than males on the social aspects of science factor. Nosek, Smyth, Syriram, Lindner, Devos, et al (2009) stated that experimental research has demonstrated causal effects of implicit stereotypes on such inequalities and suggested observation of inequalities can influence stereotypes. McLaren and Gaskell (1995) argued that by reading the culture and interviewing girls' experience in science class, it suggests that science is a male domain, and boys can more easily reproduce its messages than girls.

**Role models.** Role models, or lack thereof, can influence both young males and females, but perhaps males are more susceptible. Bauman (2012) found gender stereotypes and role modeling may be more influential for adolescent males than for females. Amelink (2009) speculated that negative attitudes about science related disciplines that are driven by gender-biased stereotypes that science is a male-dominated field may influence the number of women who pursue degrees in STEM field. Given the influence of parents' expectations for STEM education and STEM careers on the future career aspirations among females, Wang (2008) recommended that educators could inform and promote female students about career opportunities and role models in STEM fields, as well as the academic preparation needed to succeed in these fields.

**Curricular design.** In classrooms where teachers emphasize the usefulness of quantitative skills, encourage cooperative rather than competitive learning, and minimize social comparisons of ability, both females and males perform well (Eccles, 2005). By

reinforcing gender stereotypes and neglecting male areas of underachievement, the focus on gender inequities in mathematics has resulted in negative consequences for both boys and girls. School instructional and extracurricular activities may play an important role in reinforcing these patterns.

Curricula focusing on higher-level cognitive skills, critical thinking, and problem solving should emphasize quantitative skills and encourage cooperative learning to improve gender equities. According to Shymansky, Kyle, and Alport (1982) the new science curricula had consistently positive effects on student performance regardless of grade level. Students like science better when taught as inquiry, without sacrifice in achievement or related basic skills. Haussler and Hoffmann (2002) found an intervention that adapted the curriculum to the interests of girls and which promoted the ability of girls resulted in improved immediate and long-term achievements for both boys and girls among German students.

Also, there is still much that can be done to change the masculine image of science (Meece, Glienke, & Burg, 2006). Brickhouse, Lowery, and Schultz (2000) cited that the girls related to science in diverse ways and argued that the girls could benefit from a curriculum that permitted more diversity in the ways students might engage in and use science content. Freedman (2001) reported that female students who had regular laboratory instruction scored significantly higher on the objective examination of achievement in science knowledge than female students who had no laboratory experiences. Jacob (2005) found that girls achieved greater success in and/or a stronger identification with such subjects when they are part of the compulsory school curriculum.

Further, girls were to become 'empowered' through the reconstruction of the processes and contents of the curricula in these areas. (p.2).

Ormrod (2007) recommended that training should include assuring that girls and boys have equal potential in all areas of the curriculum and encouraging students to cross stereotypical boundaries in course selection. Ormrod argued that the curriculum must be designed to counter the notion that science is not for girls and assure students that girls and boys have equal potential in all areas of the academic curriculum. Myers (2007) argued that teachers and school managers need practical guidance on the legal context for gender equality and on how to develop an appropriate school climate as well as information on teaching, subject content and assessment. Cunningham (2007) found that extracurricular and informal learning experiences, including participation in science competitions or science-related field trips, promote females' science achievement and interest in engineering.

Teacher gender can also have an effect on boys' and girls' achievement in science. The same gender teacher raises the achievement of males and females, Tize, Jensen, and Heil (2011). Grade 12 girls attending a single sex school outperformed their same sex counterparts attending co-educational schools. In grade 8, no differences between both groups were observed. The well-known gender difference between 12th grade boys and co-educative girls had been found.

Amelink (2009) argued that "Teacher attitudes and behaviors may vary depending on the gender of the student, possibly creating classroom climates that are biased towards males" (p.16). Amelink further claimed negative attitudes about science related disciplines that are driven by gender-biased stereotypes may influence the number of

women who pursue degrees in the STEM field. Dee (2006) argued boys and girls benefit by having male and female teachers as role models, stating “the gender interactions between teachers and students have statistically significant effects on a diverse set of educational outcomes: test scores, teacher perceptions of student performance” (p. 222). Interestingly, Dee found that having a female teacher instead of a male teacher raised the achievement of girls and lowered that of boys in science.

According to Schroeder, Scott, Tolson, Huang, and Lee (2007) instructional environments that utilize a variety of strategies and employ pedagogical strategies that address different learning styles have been shown to encourage female achievement in science classrooms. Females tend to do better in science content areas that are linked to people. Davenport, Mark, and Davison (1989) examined the two central terms of the problem ‘gender’ and ‘science’ and how the materials are used in science classes. Teaching science deconstructively will create the kinds of symbolic spaces which are needed if young women are to find ways to intellectually engage with science as both its subjects and as women. Santrock (2008) observed that when hands-on lab activities were emphasized in science classes girls' science test scores improved.

Sandler, Silverberg, and Hall (1996) found that assessments at the national level and employed in classrooms used to measure science achievement should be reviewed for gender bias given the reported trends associated with female achievement in high school science courses that is comparable to male counterparts. Instructional professionals, including administrators, should examine gender bias that may be inherent in science classrooms including teacher’s attitudes, behaviors, and pedagogical strategies. By reinforcing gender stereotypes and neglecting male areas of underachievement, the focus

on gender inequities in mathematics has resulted in negative consequences for both boys and girls. School instructional and extracurricular activities may play an important role in reinforcing these patterns. Also, there is still much that can be done to change the masculine image of science (Meece, Glienke, & Burg, 2006). AWE (2009) suggested the classroom climates factor might facilitate male learning in science, stereotypes, community support, and assessments used might have gender bias. Female adolescents reported receiving statistically significantly more educational encouragement from teachers than did male adolescents (Khan, 2012).

Haussler and Hoffmann (2002) found training teachers to promote the physics-related self-concept of girls has no effect on achievement but it does improve the variables of the affective domain to some degree. They also found teaching girls and boys separately has a positive impact on most of the cognitive and affective variables for both sexes. Kahle and Rennie (1993) achieved promising results with teacher training in gender equity in science in both Australia and the U.S. They conducted two studies; in the Australian study, teachers with both equity and skills training (rather than just skills training) were able to make the science topic more interesting for girls and in the U.S., equity training also made girls enjoy the activities as much as boys. Pollard's (1993) recommendations were similar: advocating more spending on training and procedures for enhancing women's academic achievement by building upon the particular interests and perspectives women hold. Pollard found equity training helps teachers make science equally interesting for boys and girls. Training could involve teacher training that includes strategies to promote both genders in science and counteract persistent

stereotypes and misconceptions as well as how to provide lessons appealing to both genders (AAUW, 2011).

**Family differences and parental influence.** Parents have a strong influence on children's beliefs, and they tend to have higher expectations for boys in their academic abilities and success in STEM education and careers than females. Laftman (2008) reported that the differences are that resident stepfathers' and non-resident original fathers' characteristics are not associated with a comparative advantage in STEM. Non-resident father's education occupation and geographical distance affect children's educational choice. Shinn and O'Brien (2008) cited that no differences in children's speech were found for either gender or class. Both parents used more affiliative speech with sons and more assertive speech with daughters. Mothers used more affiliative speech than fathers, and fathers used more assertive speech than mothers. Middle class parents were more affiliative in their conversational styles than working class parents (Shinn & O'Brien, 2008). Benbow and Stanley (1980) argued that there are no differences in males and females in their ability, but there are differences in support and encouragement from their teachers, peers, and parents.

Meece et al. (1992) noted that parental beliefs about their children's abilities have a strong influence on their children's own beliefs about their academic abilities. Santrock (2008) agreed that parents have higher expectations for boys' STEM skills. Wang, Oliver, and Staver (2008) reported that parents held higher perceptions of mathematical abilities and higher expectations of success in STEM education and related careers for males than for females. AWE (2009) suggested the following factors influence females' lower science test scores and low numbers in certain science fields (although not others):

females prefer humanitarian areas, parents' expectations and perceptions, classroom climates might facilitate male learning in science, stereotypes, community support, and assessments used might have gender bias. Khan (2012) found evidence that female adolescents reported receiving statistically significantly more educational encouragement from their mothers, fathers, friends, and teachers than did male adolescents.

Yongmin and Yuanzhang (2011) discovered that the analysis found that children in non- disrupted two-biological parent and non-disruptive stepparent households consistently made greater progress in their math and reading performances over time than their peers in non-disrupted single-parent, disrupted two-biological parent, disrupted alternative families with multiple transitions. Children in such families consistently made more academic progress than their peers in three of the four alternative groups, showing as much progress in math over time as their peers in non- disrupted two-biological parent families. Sevinc, Ozmen, and Yigit (2011) observed and parents' educational levels did not have effect on students' motivation.

**Peer influence.** Boys and girls interact with peers in different ways. Ormrod (2007) observed that boys and girls interact with peers in distinctly different ways. Santrock (2008) noted that peers extensively reward and punish gender-related behavior, creating a set of gender-appropriate/-inappropriate behaviors and interests. Adolescent girls have suggested frequency of activity with friends the most significant independent predictor of each girl's activity, suggesting that peer support is a more powerful influence on physical activity participation on girls compared to boys (Bungum & Vincent, 1997; Voorhees et al., 2005). Khan (2012) found that female adolescents reported receiving statistically significantly more educational encouragement from their friends than did



male adolescents. McLaren and Gaskell (1995) argued this may have been related to the girls' unwillingness to accept that gender biases and harassment affects their interests from their peers.

### **Personal/Psychological Factors**

Personal and psychological factors potentially affecting the long-term college major and career choices of males and females include self-concept, self-belief, self-efficacy, self-esteem, self-regulation, self-reflection, self-competence, motivation, attitudes, anxiety, intentions, and agency. Meece et al. (1992) reported a key aspect of identity development is to integrate self-conceptions with societal expectations and opportunities. However, Riding and Rayner (2001) claimed that self-beliefs and the related psychological concepts (e.g. self-concept, self-esteem, self-efficacy, self-perception, etc.) have not been clearly or consistently defined. As a result, although different terms are used in the sub-sections below, some of the terms may overlap each other.

**Self-concept.** Some slight but generally not significant differences between males and females in self-concept have been found that slightly favor males. Benbow and Stanley (1980) observed that girls' self-perceptions of STEM ability are still below boys'. Despite the lack of gender differences in intelligence, boys and girls judge their capabilities in these academic domains differently. Spinath and Plomin (2008) noted that boys are more self-perceptive than females in math.

Wang (2008) reported that self-concept and science achievement, upon closer examination, not reciprocal. Ormrod (2007) said of the gender schema that it is a self-constructed, organized set of beliefs about the characteristics of men and women. Wilkins

(2004) and Ormrod (2007) cited that boys appear to have a slightly more positive overall sense of self than girls do. According to Wilkins(2004) an International study showed that a relationship between self-concept and science achievement was positive. Amelink (2009) argued that science achievements may be related to students' self-concept and interest" (Synthesis of findings section, para.5).

Wender (2004) said that people who have low self-concept and self-efficacy tend to shy away from difficult tasks, have low aspirations, give up quickly, and lose faith in their abilities. Wender claimed, "Self-concept influences the development of interests and interests shape self-concept" (p.46). Rudasill and et al. (2009) observed that gifted students' score in several self-concept domains were lower for older adolescents and girls, but remained relatively high across grade and gender for scholastic self-concept.

Van de gaer, Pustlens, Van Damme, and De Munter (2008) noted that boys attach a higher value and utility to math for career choices and have higher self-concept in math explain why they choose to participate more in math than girls. Skaalvik and Skaalvik (2004) reported that male students had higher self-concept, performance expectations, intrinsic motivation, and self-enhancing ego orientation in mathematics and then did female students. Barnby, Kind, and Jones (2008) stated that girls tend to have a slightly lower self-concept in science, and it also decreases in higher grade levels. Feingold (1994) found that females scored much higher than males on tender-mindedness. Males scored higher than females, to a medium degree, only on assertiveness. Jacobs (2005) suggested that middle schools and high schools should emphasize both self-concepts of ability and interest in these topic subjects of science and technology for males and

females of all ethnicities which seek to develop their important human capacity to be sensitive, imaginative, empathetic, sympathetic, creative and perceptive (p.23).

**Self-belief.** No significant difference between males and females was found in self-belief. Jacobs, Lanza, Osgood, Eccles, and Wigfield (2002) reported that when children believe that they have the ability to accomplish a particular task, they perform better and are more motivated to select increasingly challenging tasks. This focuses on the domain-specific self-competence beliefs and domain-specific motivation and performance. Crombie et al. (2005) found that girls' competence beliefs in math had a central role for predicting not only current math grades, but also future math enrollment intentions. The path from intrinsic value to intentions was not significant for either girls or boys. Barmby, Kind, and Jones (2008) cited that evidence suggests that future participation in science differs significantly by gender, which may be affected by personal beliefs in science.

**Self-efficacy.** No significant difference between males and females was found in self-efficacy. Santrock (2008) defined self-efficacy as “the belief that one can master a situation and produce positive outcomes” (p. 244). Sevinc, Ozmen, and Yigit (2011) cited that in term of the ‘self-efficacy’ sub factor, significant difference has been determined on students’ motivation level towards science learning according to variables such as “academic success and taking private lesson”. Riding and Rayner (2001) claimed that self-beliefs and the related psychological concepts (e.g. self-concept, self-esteem, self-efficacy, self-perception, etc.) have not been clearly or consistently defined.

Kiran and Sungur (2012) observed that no gender difference was found concerning science self-efficacy and strategy use. There is a positive association between

science self-efficacy and strategy use. The relationship between science self-efficacy and its proposed sources does not change as a function of gender. All proposed sources, except for vicarious experience, were found to be significantly related to student's scientific self-efficacy. Girls were found to experience significantly more emotional arousal and to send positive messages to others more than boys. McLaren, & Gaskell (1995) found that many of the female participants they interviewed in a high school physics course reported perceiving physics as coming easier to the male students than the females, and some reported that boys maintained their status in the physics classroom by harassing the girls.

Wender (2004) discovered that people who have low self-concept and self-efficacy tend to shy away from difficult tasks, have low aspirations, give up quickly, and lose faith in their abilities. Observed, low self-efficacy leads to low aspirations, lower persistence, and weak commitment to goals. Women typically judge their self-efficacy as lower in occupations requiring quantitative skills, such as engineering and computing. Benbow and Stanley (1980) cited that as students move into high school, girls lose their confidence in their ability in math.

Britner (2007) found that self-efficacy varies for males and females depending on the specific type of science course. For boys, mastery experience is the only significant predictor of self-efficacy and course grades in physical and earth/environment science. For boys, in life science, self-concept was the strongest predictor of grades and self-efficacy. Girls in life science class earned higher grades than boys, but their higher level of achievement did not result in girls' reporting higher levels of mastery nor a stronger self-efficacy and self-concept related to science activities and therefore not a significant

predictor of self-efficacy as they were for boys. Concerns of being competent with feelings of anxiety may be a factor of girls' lack of persistence in science-related courses and careers. Britner (2007) cited that social persuasions had the strongest effect on girls' self-efficacy, an importance of relationships to girls' perseverance in the science fields. Girls concerned about the appearance of ineptitude in science class earned lower grades, for girls less concerned about the issue earned higher grades (Britner, 2007).

**Self-esteem.** No significant difference between males and females was found in self-esteem (Feingold, 1994). Bachman, O'Malley, Freedman-Doan, Trzesniewski, and Donnellan (2011) found that age differences (8<sup>th</sup>, 10<sup>th</sup>, and 12<sup>th</sup> grades) in self-esteem are modest with 12 graders reporting the highest scores. Linear coefficients show small but significant increases in self-esteem among females in all three grades. Scores among adolescents in the U.S. are strongly in the direction of high self-esteem.

**Self-regulation.** Girls are frequently reported to have higher levels of self-regulation in school, including in STEM. According to Schunk (2004) self-regulation is one of five types of cognitive capabilities. Self-regulatory capability is that humans develop internal standards that enable them to evaluate behavior. Self-regulation consistently predicted math awareness, links were stronger with the direct measure as compared with teacher reports. Matthews, Morrison, Cameron, and Pontiz (2009) found girls outperformed boys in both assessments: Child Behavior Rating Scale (CBS) Teacher report of classroom self-regulatory behavior.

**Self-competence.** Boys typically exhibit higher self-competence beliefs in STEM than females. Crombie, Sinclair, Silverthorn, Byrne, DuBois, and Trinner (2005) have studied grade 9 boys (263) and girls (277). Gender similarities were found particularly in

the prediction of math grades. There were two gender-specific paths for girls, a direct path from competence beliefs to enrollment intentions, and for boys, the path from utility to enrollment intentions which was stronger than it was for girls. These patterns were found even though girls and boys reported similar levels of math utility and girls had lower math competence beliefs. For girls, competence beliefs were a significant predictor of both intentions and current math grades, which indicates the central role of competence beliefs. Jacobs et al. (2002) discovered that male students held higher self-competence beliefs in math than female.

**Motivation.** Significant difference between males and females was found in motivation goals of males and females and males aspire to high earning science and math careers at a higher rate than females. Meece et al. (1992) found that the gender gap in motivation related to mathematics and science has narrowed. Sevinc, Ozmen, and Yigit (2011) discovered that the motivation level of female students was higher than male students. Academic achievement and taking private courses increased the motivation. Gender academic success and taking private lessons had an effect in students' motivation levels towards science learning. There was a significant difference on students' motivation level towards science learning according to gender, academic success and taking private courses. Bridgeman, and Wendler (1991) found that differential motivation of men and women could explain the within-course grade differences.

Koul, Lerdpornkulrat, and Chantara (2011) observed that among male and female high school students there were significant differences in the motivation goal of males and females. Occupational choice is influenced by the value students place in a subject area. Gender differences in the motivational factors that influence career aspirations are

those differences that may result from social preferences. Thai females are likely to choose occupations that can easily be combined with family and child rearing and which increase their productivity in both the marketplace and home. Females were significantly more motivated by intrinsic factors and the value of studying science. The decision to enroll in advanced math was mediated by gender differences of value in math. Males aspired to HESME “High earning Science and Math” professions at higher rate than females. Males are more performance goal oriented. Females who are non-competitive discourage other females from adopting performance goals. Instrumental goal orientation toward science contributed positively to the choice of a HESME profession for males and females. For females only there was a positive aspect of performance and socio-cultural goal orientation. Science, math or engineering fields may not be the best qualified careers that require science and math proficiency for students who aspire to high earning.

Jacobs, Lanza, Osgood, Eccles, and Wigfield (2002) cited that when children believe that they have the ability to accomplish a particular task, they perform better and are more motivated to select increasingly challenging tasks. This focuses on the domain-specific self-competence beliefs and domain-specific motivation and performance. Spinath, Spinath, and Plomin (2008) found that boys have more intrinsic values than females in math.

**Attitudes.** Males tend to report more positive attitudes than females and aspire to high earning science and math career at a higher rate than females. At the general level, students reflect a greater positive attitude for boys. The high-performance students indicate a greater positive attitude for girls (Weinburgh, 1995). Britner (2007) found that the mastery experience of boys is the only significant predictor of self-efficacy and

course grades in physical and earth/environment science. For boys in life science, self-concept was the strongest predictor of grades and self-efficacy. Girls in life science class earned higher grades than boys, but their higher level of achievement did not result in girls' reporting higher levels of mastery nor a stronger self-efficacy and self-concept related to science activities and therefore not a significant predictor of self-efficacy as they were for boys. Concerns of being competent with feelings of anxiety may be a factor of girls' lack of persistence in science-related courses and careers.

According to Weinburgh (1995) boys have more positive attitudes toward science than girls. Boys show more positive attitudes toward science than girls in all types of science. The correlation between attitude and achievement for boys and girls as a function of science type indicates that for biology and physics the correlation is positive for both, but stronger for girls than boys. Amelink (2009) claimed negative attitudes about science related disciplines that are driven by gender-biased stereotypes may influence the number of women who pursue degrees in STEM field.

**Anxiety.** Females scored higher than males, to a small degree on a scale of anxiety, but the effects can be remedied. Goetz, Bieg, Ludtke, Pekrun, and Hall (2013) found that no gender differences were observed for state anxiety but females reported significantly lower trait anxiety in mathematics. In this study, state anxiety referred to being anxious at the moment of being in a class or taking a test (in the current state), while trait anxiety referred to how they felt about their levels of math anxiety in general (as a personal trait) (Goetz et al., 2013). This suggests that females habitually overestimate their anxiety as a general trait, even though they do not experience uniquely high levels of anxiety during the class. Female students reported lower perceived



competence than male students despite having the same average grades in math. Female students' reported higher levels of anxiety than do male students on trial self-report. Bui and Alfaro (2011) cited that anxiety was inversely related to attitudes towards science; however, they found no significant differences between males and females. Benbow and Stanley (1980) argued that the test anxiety and performance avoidance goals accounted for all of the gender differences in SAT scores and overall SAT performance as a result of social/learning factors. Two social/personality factors which appear to influence this phenomenon: correlations indicate that females experience more test anxiety and have higher performance-avoidance goals.

Feingold (1994) observed that females were higher than males in extraversion, anxiety, trust, and, especially, tender-mindedness. Females scored higher than males, to a small degree, on a scale of anxiety and trust. Females exhibited higher anxiety and males, higher assertiveness. Meece (1981) argued that while girls exhibit higher anxiety, the degree of anxiety students experience does not necessarily inhibit achievement. Britner (2007) found in earth/environmental Science course that girls have higher course grades and stronger self-efficacy; they show lower science anxiety.

**Forethought/intentions.** The future intentions of female students in pursuit of STEM careers may be discouraged by female gender stereotypes in STEM fields. Bauman and Sheri (2012) cited that the boys all aspired to stereotypically male jobs or gender-neutral jobs, and their choices were significantly different from what would be expected by chance. 45 percent of the girls listed stereotypically male jobs for their career aspirations. Only 21 percent aspired to traditional female jobs, while the remainder chose gender-neutral occupations. The boys pursue utility to enrollment intentions which are

stronger than girls. The path for girls is directly from competence beliefs to enrollment intentions, even though girls and boys reported similar levels of math utility. Girls had lower math competence beliefs. For girls, competence beliefs were a significant predictor of both intentions and current math grades. The path from intrinsic value to intention was not significant for either girls or boys (Crombie et al., 2005).

**Beliefs and agency.** The highest factor in women's underrepresentation is choices made freely and forced or controlled by biology and society. Ceci and Williams (2010) said,

Sex differences in mathematical and spatial ability, although substantial, appear unable to explain most of the shortage. Nor can the shortage be attributed to current discrimination, although historic discrepancies may be explained in such terms. The primary factor in women's underrepresentation is choices both freely made and constrained by biology and society. (p. 142)

Though choices are freely made, they are constrained by environmental obstacles, both real and imagined. For example, Ceci and Williams cite evidence that women have experienced increasing opportunities to interview and fill positions in the STEM fields that are comparable or even surpass males, but if the perception of a lack of opportunity persists, it can still affect the choices and perceived agency of individuals. As Kralina (2010) notes, perception is reality when it comes to choices made and interests held, finding that the previously held beliefs students had about a science program influenced who chose to participate.

## **Summary**

Chapter 2 reviewed the current literature on gender differences in STEM courses. The literature review reported findings on gender differences in STEM throughout history and between cultures before focusing on the current state in the US. The literature clearly demonstrates that gender differences in STEM ability, performance, and preferences are largely influenced by the environment, including historical and culture differences.

The subtopics explored included differences in grades, test scores, course preferences, college major enrollment, and career choices. As access to education and career options has become more equitable for male and female students, the gender gap in these areas has closed in STEM educational achievements. However, one gender gap persists more than others: the difference in choices of college majors and, subsequently, career paths. Males are still overrepresented in STEM fields that are highly technical and theoretical, while females are overrepresented in STEM fields that are more social-, life-, and health-science related.

Next, the review summarizes the findings on various proposed reasons for the observed differences, including biological, environmental, and personal factors. The literature seems to suggest that biological factors are of minimal influence at best, whereas some kind of interrelation between environmental factors and the gender variations in self-concept and self-belief (and the related sub-factors of these self-constructs) appear to be more influential

## Chapter Three

### Pilot Study

Before this dissertation, I conducted a pilot study with two parts that provides the background to the current research question and methods. The first part of the pilot study used quantitative methods to investigate 8<sup>th</sup> grade middle school students in science class (n=208; 80 males, 128 females). The first part of the pilot focused on why significantly more men than women are employed in STEM fields, especially engineering, computer science, and physical science careers. I hypothesized that male and female 8<sup>th</sup> grade students differ from each other in their self-belief, learning style preferences, and course choices in science.

The second part of the pilot used mixed methods to investigate a similar question, but addressed older students (11<sup>th</sup> and 12<sup>th</sup> graders) in both science and math courses (n=36; 15 males, 21 females). This part included both a survey analyzed quantitatively (n=36) and an interview with a subgroup within the original sample analyzed qualitatively (n=4; 2 males, 2 females). In the second part of the pilot, I hypothesized that male and female 11<sup>th</sup> and 12<sup>th</sup> grade students differ from each other in their self-belief, learning style preferences, and course choices in science and math. The second part included the additional hypothesis that the interview would reveal possible reasons for the differences.

### **Pilot: Part I**

#### **Subjects/Participants**

The target population for this part of the pilot was 8<sup>th</sup> grade middle school students in science classes in Northwest Ohio. The sample of this study was drawn from

8<sup>th</sup> grade middle school students in science class from 12 middle schools (11 public schools & one charter school) in Toledo, Ohio. Based on school district reports, there are 14,646 K-8 students in the largest public school district in Toledo, and approximately 1628 students in the 8<sup>th</sup> grade. A total of 208 students participated in this study, 38.5% of whom were males (n=80) and 61.5% females (n=128). The average age of the sample was 13.7 years, the youngest of whom was 12 and the oldest were two 16 year olds.

### **Instrumentation**

The research instrument in the first part of the pilot study was a researcher-created self-report questionnaire comprising 15 items divided into seven parts about attitudes and preferences in biology and physics. The seven parts were: attitudes about science (three items on a 5-point Likert-type scale); course description choices (two items choosing between two course descriptions); ranking preferences of biology materials (from 1-5 with 1 being most interesting); ranking preferences of physics materials (same ranking scale); activity preferences in biology (four items choosing between two choices each); activity preferences in physics (three items choosing between two choices each); and individual versus group work preference (one item). The reliability of the survey was not tested. However, in order to strengthen the validity, feedback was gathered from three professors in the educational field.

### **Data Collection Procedures**

To collect the data about 8<sup>th</sup> grade student preferences and attitudes in science, the above instrument was administered to the sample of students in Toledo. In accordance with the University of Toledo's Institutional Review Board (IRB), the first step of collecting the data required getting permission from the school boards to allow the rest of

the study to be conducted. One school board in a large public school system in the region agreed to allow the survey to be administered to students in the district, which consisted of 11 public schools. Additionally, the principal of the one participating charter school gave permission to have research conducted on site. After the school board approval, the IRB approved the rest of the data collection procedures.

I visited the schools in person to explain the research to the principal and get their verbal permission, although this step was not required by the IRB. Afterwards, I contacted the science teachers either immediately in person or at a later appointed date in person, during which I gave them the consent forms for the teachers and parents. Out of the 12 science teacher, four were unable to meet in person, so I gave the parent and teacher consent forms to a secretary to distribute to the teachers. I followed up with the teachers by phone or email two to three weeks later to check if the teacher had signed their consent form and collected the signed copies of the parents' consent forms. Once all the consent forms for the teachers and some of forms for the parents who did sign the consent form, although there were parents who did not sign.

Finally, after I collected all the permission and consent from the relevant adults, I visited the classrooms in person to introduce myself and the study and distribute the child assent form and survey. Only students whose parents signed consent forms received assent forms and surveys. Students who decided not to give their assent were not asked to complete the survey. Those students who assented to the study and completed the survey took anywhere from 20 to 30 minutes to complete it.

## **Data Analysis Procedures**

To analyze the survey data collected above, I used one-way and analysis of variance (ANOVA) and factorial ANOVA with the aid of the Statistical Package for the Statistical Sciences (SPSS ver. 21.0.0.0; IBM, 2012). The one-way ANOVA test was applied to the final question of the survey “I prefer lab work that emphasizes: individual work / group work,” while the factorial ANOVA was applied to the other 14 items of the survey.

## **Results**

The eighth grade males and females differed significantly in their reported enjoyment of science ( $p < 0.05$ ). The male students reported enjoying science more than the female students. The males and females in this study significantly differed in their beliefs about their science ability ( $p < 0.05$ ). The male eighth graders reported a higher belief in their science ability than the female students.

In terms of preferences for learning materials, there were some significant differences: boys reported preferring high tech lab equipment in the biology classroom ( $p < 0.05$ ), while girls reported preferring the use of nurseries, aquariums, and cages of animals in the biology classroom ( $p < 0.05$ ). As for the physics classroom, on one hand girls reported a preferences for posters as a learning material more than boys ( $p < 0.05$ ). Boys, on the other hand, reported a preference for using complex machines ( $p < 0.05$ ) and electrical circuits ( $p < 0.05$ ) as learning materials in the physics classroom.

In class activities, girls reported that they prefer watching the metamorphoses of butterflies over time while boys reported a preference for dissecting butterfly cocoons ( $p < 0.05$ ) in the biology classroom. In the physics classroom, boys reported preferring

individual work more than girls ( $p < 0.05$ ). Additionally, boys reported liking to take apart car parts in the classroom more than girls ( $p < 0.05$ ).

There were no significant differences in the types of biology and physics courses males and females chose based on course descriptions. There was also no significant gender difference found in the preference of individual lab work versus group lab work.

### **Discussion and Conclusions**

There were a few significant differences between the eighth grade male and female students. The major differences were in attitude and preferences towards activities and materials. The male students had a more positive attitude towards science and thought more highly of their own ability than the female students. Also, the boys reported a preference for activities and materials that involved taking things apart and dissecting them, whereas the girls reported a preference for watching living things interact, grow, and change.

These findings suggest that eighth grade science teachers need to be aware of the needs and preferences of both genders and to design activities that appeal to both. If some activities involve dissecting dead animals, then others should involve observing living things to balance out both types of interests.

There are many limitations to these findings. The first limitation is that it only applies to eighth graders between the ages of 12-16. This age range is unique because of puberty and sexual maturation. Previous studies have found that self-esteem differences at this age become less pronounced at older ages (Bachman et al., 2011). In other words, female teenagers will report a belief that they have a lower ability in science more in eighth grade than in 12<sup>th</sup> grade (Bachman et al., 2011). Another limitation is the



reliability and validity of the survey, created by the researcher. Without a theoretical framework to justify each question and without reliability statistics, these findings may not reflect actual differences between the male and female eighth graders. It is possible that the way the questions were worded were gender biased. Along these same lines, the analysis was conducted separately for each item in the survey rather than for a composite score or groups of composite scores, so the strength of the findings is questionable.

Future studies need to analyze older students to see what kinds of differences persist and what kinds do not. Moreover, qualitative interview data about self-beliefs may be more valuable than quantitative data at this point because the fact that gender differences are small and temporary has been well-established quantitatively, but the power and persistence of the myth of gender differences in STEM held by high school students has not been investigated as much.

## **Pilot: Part II**

### **Participants**

The sampling method for the second part of the pilot was convenience sampling. The second part included a survey group and an interview subgroup. The survey group comprised 36 student participants (15 males, 21 females) who were 11<sup>th</sup> and 12<sup>th</sup> graders in both science and math courses in Northwest Ohio. Of the 36 students, I surveyed 28 from one public urban school in Northwest Ohio and eight from a public suburban high school in the same region. To recruit the samples, I first asked the principal from each school to identify courses and willing teachers.

The principal from the urban public HS referred me to the chair of the science department who told me she could draw from a total of 90 11th and 12th graders from her

courses. The science chair found interested students by promising extra credit to participants. Of the 90 possible, only 28 (31%) of the students and their parents signed the necessary forms to participate.

At the suburban HS, the principal directly recruited the students. He originally stated he could draw from a class of 30 students, from which 8 (26.6%) agreed and provided signatures from their parents and selves. To my knowledge, the principal did not provide the students an incentive for participation.

I also selected a subgroup of four interview participants from within the 36 students from the survey. Specifically, the four interviewees came from the eight suburban HS survey sample. To recruit these four interviewees, I asked the principal to find an equal number of female and male students who would be willing and able to meet. In the end, the principal found two males and two females who participated in the interview.

### **Instrumentation**

The survey for pilot 2 included six items using a five-point Likert-type scale about their attitude towards science and math. The second part included four items that involved choosing one out of two course descriptions based on preferences in STEM courses. Two of the items were for science courses (biology and physics) and two were for math courses (algebra and geometry). The third part involved two items that asked the student to rank course materials in biology and physics from 1 to 5, with 1 being most interesting. Part four included six items that each asked the student to choose one out of two activities in biology (three items) and physics (three items). The fifth part asked if the student preferred individual or group lab work. The sixth part requested the student to

provide information on their male and female peers' college intentions (six items). The final part asked about the students own college and career interests (three items). The survey was researcher-created, not validated, and not tested for reliability.

The interview was structured around 18 questions. I shared the interview questions with my dissertation committee for feedback. Based on the feedback, I reworded two of the questions about their favorite teachers to avoid asking identifying information. The interview process began with introducing myself and the purpose of the study, followed by questions about the interviewees' age, gender, and school. After the introductions and collection of background information, I asked the four students the same 18 questions.

## **Results**

Almost no gender significant differences in attitude and preferences in STEM were found among the 11<sup>th</sup> and 12<sup>th</sup> grade male and female students. The genders only differed on one item, which asked the student to choose between two activities in physics class ( $p < 0.05$ ). In this item, female students reported preferring to learn about how physics can help save lives in cars using airbags, seatbelts, and center of gravity, whereas male students reported a greater preference for taking apart a car engine to see the various simple machines that work together.

Another significant gender difference was found in the choice of a future career: more females reported the desire to have a career with a math component more than males ( $p < 0.05$ ). Other than these questions, the gender reported similar attitudes and preferences. However, their beliefs about gender differences based on interview questions varied from person to person.

**Male, 17, AP calculus and AP physics.** This student expressed a lot of interest and passion for high level mathematics. Showing his enthusiasm for the subject, he said, “Math It has always come easy. It makes sense. Calculus was fun. I like connect things.” He also stated that calculus is no more difficult than algebra but a lot more powerful at solving complex problems.

In response to questions about which gender has stronger math skills, this student responded, “Males. I nearly [sic] don’t think there is a difference, but I see more males in higher classes.” As for science courses, he said, “Science is more even than math, but I still see more males active in class over females.” In both cases, he did not feel that he could say they are perfectly equal, although at the same time he said they are not that different. This shows a belief that slightly favors male students.

When asked to explain why there is a difference in the number of males and females in STEM fields even though they have similar ability, he stated:

I think females have more interests such as directly helping others, teaching, public service, and so on. Males tend to stay to STEM because it seems cooler and it has a lot of adventure in it still. Females may want to communicate more with others for a job instead of dealing with numbers.

Two beliefs that are expressed in this quote are that this student believes females tend to prefer fields related to helping others, whereas males tend to prefer excitement and adventure.

**Male, 18, calculus and AP physics.** This student’s responses showed he appreciates subjects that have clear answers or solutions. He likes knowing exactly what is right and what is wrong. He stated his favorite subject is “Math, because there is

always an answer.” Within math, he likes calculus most “Because it brings everything together.” Similarly, he likes chemistry more than any other science “because it is easy to test how things works.”

When asked about which gender is better at STEM, he stated in both subjects the genders are equal. He stated his belief that males and females are equal in STEM more directly confidently than any of the interviewees, in one word “Equal.”

When he was asked to explain why he thought females do not tend to major in the highest levels of STEM and have careers in demanding STEM fields as much as males, he said:

I feel like the world and society is sort of against women going into STEM heavy fields, where women are more prominent in teaching. I feel like it is in the brain that females are meant to be more compassionate.

From this quote, this young man included potential reasons: social obstacles and personal characteristics. Like the other male student, he believes females tend towards more compassionate and caring fields.

**Female, 17, AP calculus and AP physics.** This students’ interests in science come from the subject’s application to her career goals. Of the sciences, she stated she prefers chemistry. When asked why, she said, “because it interests me most out of all subjects and I’ll need it for my profession [veterinary science].” She also likes the lab work involved in chemistry.

When she was asked which gender excels more in STEM in her opinion, she said females. When asked why, she said, “Females’ maturity level is higher.” This means that

she does not see the differences as related to intelligence or ability *per se*, but rather a result of the maturity of their behavior.

When asked to explain the phenomenon of more males in the highest levels and careers in STEM even though the abilities and intelligence levels are virtually equal, she said,

“I think males choose those careers, because it’s in their nature to be the higher guy and take care of others, as it’s always been. Society takes a big role in that.” She clearly sees social structures and personal goals to make money as the driving factors.

**Female, 16, algebra and chemistry.** This student had the lowest level of STEM education of all the others and also showed the least interest in these subjects. She likes science, but for different reasons than the others. She stated “science, as art, can be creative and there is no one right answer.” However, she said she does not like math and does not believe she is good at it. If she had to pick one math course she does enjoy, though, she said “Geometry” because she is “Good with shapes.” She wants to be an interior designer, which depends on geometric skills.

When asked which gender she thought has better STEM skills, she said both are equal. She noted, that “everyone is different,” even though she thinks “both are equal.” She acknowledged that there is a variety of differences, but they are not related to gender.

When she had to explain the reasons for more males in high-level STEM careers despite the equal skills and abilities of males and females in these subjects, she explained it by social demands and salary. She said, “Men hear the stereotype of making the money of the house so they need to have a higher paying job.” Therefore, she equated higher levels of STEM with higher pay, and higher pay with more attraction of males.

## **Discussion and Conclusions**

Unlike the eighth graders in the first pilot study, very few differences were found among the male and female 11<sup>th</sup>-12<sup>th</sup> grade students. Of all the questions, the genders only differed on one course activity preference and in one career choice. Other than these two, no other differences were found. This supports previous literature that few if any differences between genders exists in STEM.

The results of the interviews show that some of the students still perceive gender differences in STEM even though there is no evidence for this. Half of the students saw the genders as equal, while the other half saw them as different. Interestingly, one of the students who reported a belief in gender differences actually thought females are better at STEM, while the other believed males are better. This suggests that the belief that males have stronger ability and interest in STEM does not have much strength these days, but at the same time it is not totally gone.

The male and female interviewees explained why more males pursue degrees and careers in mathematically demanding fields differently. The female interviewees explained this difference based on male stereotypes, whereas the male interviewees explained it using female stereotypes. A shared explanation among the female students was that males still believe they need to be the main money-earner in the family, so they seek the higher paying and more demanding jobs. On the other hand, the male interviewees seemed to think that females choose their majors and careers based more on interests and innate abilities than salary. The males said that females are more “compassionate” and prefer to “communicate more with others” than “work with

numbers.” These gender stereotypes show that each gender oversimplifies the other gender to explain this phenomenon.

The survey and methods of this second part of the pilot suffer from similar problems and limitations as the first part. The survey lacked validity and reliability evidence, so it is difficult to generalize these findings. As for the interviews, there were no follow-up sessions and the interviewees were not asked to clarify some of their vaguer answers. Also, only four students were interviewed and they were selected by the principal, so they might be the best students the school had to offer.

### **Summary**

The proposed dissertation purpose and methods developed from the results of the pilot study. In particular, the pilot results showed that there are very few differences between males and females at the 8<sup>th</sup> grade level and most of those differences were not even seen among the students in the 11<sup>th</sup> and 12<sup>th</sup> grades. In light of these findings and the literature, the evidence shows there are no significant differences in males and females in STEM ability and preferences, but there are still environmental, social, and career differences. The interviews from the second part of the pilot produced some interesting preliminary themes that will be explored more in this proposed dissertation. More interviews should be conducted to determine how students explain beliefs and myths about the phenomenon of more males in highly mathematical careers in the STEM field, and how students perceive that phenomenon, which is the aim of this proposed dissertation.



## Chapter Four

### Theoretical Framework

This chapter explains the feminist theory in general and the gender difference theory in particular, and then narrows the focus to feminist phenomenology in STEM education. Although it is common for dissertation writers to include the theoretical framework in the literature review in Chapter 2, I have chosen to include a separate chapter for the framework for two reasons. First of all, feminist theory is broad, complex, and contested. Therefore, it needs to be explicated in depth, especially in order to narrow down which interpretation of feminist theory is used in this dissertation. Second of all, methodologists such as Creswell (2007; 2009) have recommended presenting the framework in a separate chapter. His reasons include that “readers can clearly identify the theory from other components. Such a separate passage provides a complete explication of the theory section its use, and how it relates to study” (Creswell, 2009, p. 188). For the complexities and controversies that surround feminist theory, such a separated explication is needed.

#### **Feminist Theory in General**

Broadly conceived, feminist theory emphasizes the central role gender plays in society (Bogdan & Biklen, 2007). As Creswell (2007) explained, “feminist researchers see gender as a basic organizing principle that shapes the conditions of their lives” (p. 26). When it takes on a socially active agenda, feminism is dedicated to reducing gender inequality in society (Bogdan & Biklen, 2007). In the feminist perspective, gender is a socially constructed phenomena and not a biologically determined or causal relationship (Butler, 1988). Because feminism asserts that gender is socially constructed, the ways in which males and females behave are framed as “performances” or “acts” that are

reproduced and reinforced by systemic or pervasive political and social structures (Butler, 1988). Similarly, Allen (1999) defines gender performance as the compelled reiteration of norms that construct individuals as gendered.

Feminism has a few problems explaining agency versus structural determinism. By framing gender as a social construct and gendered performance compelled by society, feminism removes the agency of the individual. In other words, the individual has little to no ability to uniquely respond in the dominant construct. Feminism risks giving all the power to the dominant system at the cost of the individual or smaller groups of individuals with no apparent way of escaping or acting outside of what is socially constructed (Acker, 1987). One convincing way of resolving this dilemma is Butler's (1988) proposal that increasing awareness and sensitization to gender constructs grants some agency to manipulate the impact on women's lives.

As supported in the literature review, actual gender differences in cognitive skills and academic ability are non-existent; however, individuals still believe in and behave in response to the belief of such gender differences. As a result, a large gender disparity persists in higher education and careers in the STEM fields in which male participation and success in these fields exceeds that of females. I refer to the phenomenon of the belief in gender differences and the socially constructed obstacles that hinder female success as *the myth of gender differences*. This myth is not real in the scientific and empirical sense regarding actual measures of ability and intelligence, but it is real because it has real social implications.

## **History of Feminist Theory in Science Education**

Feminists who have investigated the role of gender in STEM education have argued that masculine values dominate these fields (Kerr, 1998). This domination of masculine values is especially true in the so-called hard sciences (Kerr, 1998). Such values include the belief in objective truth, the almost exclusive emphasis on visual, observable, and measurable confirmation of truth at the cost of other ways of knowing, such as intuition, feelings, and broad awareness. Barton (1997) claimed these implicit STEM values constitute what Foucault (1980) called a “truth regime” (p. 161).

These critical approaches to science have led some feminists to argue the project of increasing women’s representation in science is futile unless the association between masculinity and science is broken, i.e., the practice of science is radically changed (Kerr, 1998). In this perspective, some potential ways of breaking the masculine truth regime of science must move beyond the awareness and sensitization promoted by Butler (1988) and into ways of actually reforming STEM education. Barton (1997) asserted that in order to reform STEM education into a more inclusive field for women, three radical efforts need to occur beyond awareness and sensitization: (a) critiques of science; (b) knowledge of positionality; and (c) the creation of a new language. These factors are essential in order to construct a liberatory science education for all (Barton, 1997).

## **Feminist Socialization Theory**

Thompson (2003) summarized the different feminist approaches to STEM education as falling into four different categories: socialization theory, gender differences theory, structural theory, and deconstructive theory. In this dissertation, I follow the Socialization theory sub- theory of feminism. Socialization theory emphasizes the norms

for social behaviors. Socialization theory is a specific focus within liberal feminism (Acker, 1987; Thompson, 2003). The main aim of liberal feminist education is to secure equal opportunities for both sexes (Acker, 1987, p. 423). Socialization is context-specific and that outside-the-home socialization takes place in the peer groups of childhood and adolescence. Intra- and intergroup processes are responsible for the transmission of culture and for environmental modification of children's personality characteristics. Socialization theorists argue that treat girls as rational and capable individuals and girls will prove themselves just as smart, independent, confident, and creative as boys (Thompson, 2003, p. 15).

The main focus of socialization theory is how access to opportunities influences choices boys and girls make. Although there is no outright denial of sex differences, liberal feminists who adopt socialization theory assert that most observable social differences are not the result of sex differences but the result of gender roles in which individuals are socialized. Gender roles can develop and get reinforced by media, peers, family, and classroom factors (e.g., teacher, textbook, and lesson plans). As a result, the focus of socialization theorists is to change these factors so that they are more open and gender neutral. The broad banner under which these efforts fit is “equal opportunities” for both boys and girls (Acker, 1987).

Acker (1987) points out that socialization theory has been criticized by radical and socialist feminists because of the limits of its conceptual framework. They argue that efforts to correct disparity in educational and career opportunities within the socialization framework have focused on heavily on the individual rather than the socioeconomic or biological factors that influence the individual, which amounts to a kind of victim

blaming (Acker, 1987). For instance, socialist feminists criticize socialization theory for neglecting the dominating influence of economic and class factors while radical feminists point out the lack of focus on sex, physical difference, and violence. However, focusing on micro and macro factors as being the most dominant factors removes agency and willpower from the teachers and students in the equation. Of all types of feminism, liberal feminism and socialization theory actually empower individuals to make change on the everyday scale.

In the field of curriculum and instruction, socialization theory has the most relevance because it empowers teachers to make some efforts to change the opportunities and treatments of boys and girls in the classroom. While the effects of these changes have not been drastic or easily measurable, it is important to keep mind that such an approach depends on small changes accumulating over a long time. Criticisms that point to a lack of immediate results are unfair because the socialization approach takes decades or longer to show results. For example, the socialization approaches of the 1960s-1980s have only started to show gender parity in academic achievements and testing results in the late 1980s and throughout the 1990s and 2000s. Now, the disparity persists in higher education and career choices, but such changes likely need another generation to manifest. Perhaps the high school students of today will be the new gender equal employees in STEM fields of the future.

Sinnes and Loken (2014) have pointed out that even in the most gender liberal societies such as Norway, there is still an alarming gender disparity in STEM careers, which leads to the question: if there is equal opportunity and many gender barriers have been removed, why do gender differences in career choices persist? Even if sex does not

determine actual ability, sex can still affect females' participation in science because we live in a gendered society where sex is a main organizing principle and as a result a major determining factor of how males and females are raised (Sinnes & Loken, 2014, p. 347).

Sinnes and Loken (2014) warned that efforts to address the gender gap in the STEM fields through educational efforts cannot depend on cosmetic solutions, which they claim has been the case in the past. They assert that a deeper feminist critique of masculinity in the STEM fields with explicit emphasis on gender inequalities is necessary to make substantial changes to the gender gap. However, Sinnes and Loken fail to acknowledge that so-called cosmetic solutions can sometimes be the starting point for future changes that have more substantial implications. The appeal of cosmetic changes is that they are at least within the power of every individual to enact.

### **Feminism and Phenomenology**

Although the overall framework of this dissertation falls within feminist socialization theory, it approaches the topic from the individual phenomenological perspective. In other words, this dissertation is an investigation of how individuals essentially experience the socialization process. So on the micro-scale, the phenomenological model is used, but at the macro-scale, the socialization theory is used. The phenomenological experience fits within the socialization processes.

Feminist phenomenology merges feminist perspectives with phenomenological ways of being (ontological phenomenology) and knowing (epistemological phenomenology). Phenomenology, pioneered by Edmund Husserl (1889/1937??) and based on the philosophical foundations of Martin Heidegger (1889/1937??), facilitates an understanding of lived experiences of individuals. Feminist phenomenology also

emphasizes lived experiences and knowing through perceiving and being, but narrows the focus to the lived experiences of being within a gendered body. One of the most influential thinkers and writers in feminist phenomenology is Simone de Beauvoir, who famously claimed, “one is not born, but, rather, becomes a woman” (as cited in Butler, 1988, p. 519). Phenomenology can strengthen the overall feminist philosophical foundation to gain a deeper understanding of the experience of living in a gendered world.

Butler (1988) asked if phenomenology can help feminism reconstruct the established character of sex, gender, and sexuality at the level of the body, and answered that query by stating that it provides a convenient focal point for investigating the way “acts” and “performances” of the individual body can both resist and reinforce expected gender roles, as well as both powerlessly spawn from existing conditions and actively alter those conditions (p. 525). In Butler’s take on feminist phenomenology, an act is an expression made by an individual that simultaneously “wears” cultural significations of society while performance is an extended series of acts that constitute a perceived identity (p. 525). Gender in this framework is not a stable identity nor a locus of agency, but a tenuously constructed “*stylized repetition of acts*...instituted through the stylization of the body” by other systemic factors (p. 519). Performing one’s gender wrongly “initiates a set of punishments both obvious and indirect, and performing it well provides the reassurance that there is an essentialism of gender identity after all” (Butler, 1988, p. 528).

With terms such as “roles,” “acts,” and “performances,” it is obvious that feminist socialization theory and feminist phenomenology depend on terms from the theatrical

world. Framing gender in theatrical terms signifies both the superficiality and reality of the experience of gender. Butler has asserted that“

Gender reality is performative which means, quite simply, that it is real only to the extent that it is performed...That gender reality is created through sustained social performances means that the very notions of an essential sex, a true or abiding masculinity or femininity, are also constituted as part of the strategy by which the performative aspect of gender is concealed. (p. 528)

Thus the reality, or essence, of gender is real only insofar as it has real consequences in the social realm, and exists between sets of performances rather than within the essence of a single individual's identity.

Bringing the theatrical metaphor of gender to its culmination, Butler (1988) concludes as follows:

As a corporeal field of cultural play, gender is a basically innovative affair, although it is quite clear that there are strict punishments for contesting the script by performing out of turn or through unwarranted improvisations. Gender is not passively scripted on the body, and neither is it determined by nature, language, the symbolic, or the overwhelming history of patriarchy. Gender is what is put on, invariably under constraint, daily and incessantly, with anxiety and pleasure, but if this continuous act is mistaken for a natural or linguistic given, power is relinquished to expand the cultural field bodily through subversive performances of various kinds. (p. 531)

It is clear from this excerpt that Butler, like many other socialization and phenomenological feminists, wants to acknowledge the influence of society and its



punitive measures and pressures without removing agency completely from the individual. She rejects a deterministic view of sex and biology as well as of social hegemony. Rather, she posits that within and between those factors exists individuals who can act. She also asserts that greater agency comes with examining such roles, acts, performances, and scripts in order to challenge, reify, or subvert them. Because of the agency granted to individuals, socialization and phenomenological feminism form the framework of this study.

### **Summary**

This dissertation follows the feminist framework at the point where socialization and phenomenology meet. In this framework, gendered behavior develops because of a complex interplay between the individual and society, where the individual learns to act and perform in certain ways to either gain approval or challenge the status quo. This worldview will inform how the data will be analyzed.

## Chapter Five

### Methods and Procedures

The purpose of this dissertation is to discover how the myth of gender differences in STEM inform the lived experiences of male and female 12<sup>th</sup> graders in one high school in Northwest Ohio. Previous research has thoroughly shown that there are no significant gender differences in STEM ability. However, there is evidence that people still *believe*, about themselves and others, that there are gender differences in STEM ability. The difference between the empirical evidence in the literature and the common beliefs of people defines the central phenomenon I will study, which I call the *myth*. Additionally, there is evidence that gender differences in academic and career choices at the highest levels in the STEM field are still skewed in favor of males, which may be affected in part by the persistence of the myth. At the end of this chapter, I describe the pilot studies and how they affected the current purpose, research question, and methodology.

Based on the literature review, the theoretical framework, the purpose of the dissertation, and the results of the pilot study, the central research question is: What experiences do male and female 12<sup>th</sup> graders in two high schools in Northwest Ohio have with the myth of gender differences in STEM? This central research question is exploratory because the purpose is to investigate the essence of the experiences with the myth, which is open-ended and not very well known. This central research question branches into three sub-questions as follows:

- What do the male and female 12<sup>th</sup> grade students believe about the myth of gender differences in STEM?

- How do the male and female 12<sup>th</sup> grade students describe their experiences with the myth of gender differences in STEM?
- What are the similarities and differences in male and female students' experiences with the myth of gender differences in STEM ability?

These sub-questions are more descriptive in nature and help support the exploratory central research questions.

In the exploration of these research questions, the feminist phenomenological conceptual framework of (who and who) will provide the lens through which I will interpret the essence of the lived experiences.

### **Phenomenological Approach**

In order to study the ways in which the students experience and perceive the myth of gender differences in STEM and answer my research questions, I used the phenomenological approach to describe the meaning for several individuals of their lived experiences of a concept or a phenomenon (Creswell, 2007). It is important to understand several individuals' common or shared experiences of phenomenon (Creswell, 2007, p. 61). I used the psychological phenomenological approach developed by Moustakas (1994), which is focused less on the interpretations of the research and more on description of the experiences of participants. The choice of the most appropriate qualitative research approach is challenging because many of the approaches share common elements. In this section, I justify the use of the phenomenological approach in contrast to either an ethnographic or case-study approach.

The first step to determine the appropriate qualitative research approach is to identify the object of interest. For case studies, the object of interest is an in-depth

understanding of a small number of extremely unique cases or even one case. For ethnographies, the object of interest is understanding the shared cultural meaning, language, beliefs, and values of a cohesive group (Creswell, 2007). For phenomenological approaches, the object of interest is discovering the essence of the experience several individuals have in relation to the phenomenon in question (Creswell, 2007). If the focus is on the individual, it is a case study. If the focus is on a group that shares a common culture, it is an ethnography. If the focus is on the experience of a phenomenon, it is a phenomenology.

Based on the various foci described above, it is clear a phenomenological approach is most appropriate for my study. The purpose of my study is to explore how male and female 12th grade students experience the phenomenon of the myth of gender differences in STEM. Through interviews, the students explained how they perceive and experience this myth and to what extent. To that end, my research questions revolved around the beliefs each individual has about the phenomenon of the persistent myth of gender differences. In the end, I want to understand the phenomenon—why the myth persists—rather than the group—how it works.

Within the phenomenological approach, there are two subtypes: hermeneutical and psychological (Cresswell, 2004). The hermeneutical approach focuses on lived experiences of the research as they reflect on essential themes of their experience with a particular phenomenon, which they then describe and interpret for the reader. In the psychological phenomenological approach pioneered by Moustakas (1994), the researcher identifies a phenomenon he or she has experienced, but then collects descriptions of the way other individuals experience the phenomenon. The researcher

brackets his or her experience so that it is separately acknowledged and then through interviews discovers how others experience it based on their descriptions of their experiences. Because I am inspired by my own experiences with the myth of gender differences in STEM and subsequently interested in how 12th grade students in Northwest Ohio experience the myth, my study approached the topic using psychological phenomenology.

This research used qualitative approaches to investigate the beliefs and perspectives among 12<sup>th</sup> grade students with different levels of STEM coursework about gender differences in science and math. The beliefs and lived experiences were gathered based on interviews. The qualitative approaches involved four meetings to gather the data about future goals and social influences of 12th grade high school students with different levels of STEM coursework. In the first meeting with students I introduced myself, explained my study, administered the consent forms for parents and assent forms for students, and scheduled future interviews. In the next two meetings, I conducted two rounds of one-on-one interviews. The final meeting was a follow-up member check to ensure the transcript and interpretations were accurate and to ask any questions for clarification.

This study followed the phenomenological method. The phenomenological method is frequently used to describe the meaning for several individuals of their lived experiences of a concept or a phenomenon, describe what all participants have in common as they experience a phenomenon, the basic purpose is to reduce individual experiences with a phenomenon to a description of the “essence” of the experience, and it has a strong philosophical component. (Creswell, 2009). Specifically, this study falls

within transcendental/psychological phenomenology (Moustakas, 1994). The process involved bracketing—to set aside experiences to take a fresh perspective. The procedures for conducting this study within phenomenology is its flexibility in the sequence of data collection will allow me to conduct the methods at different stages at different schools depending on the schedules of the various students and schools.

### **Participants**

The target population for this study was male and female 12<sup>th</sup> grade students with different levels of STEM coursework in science and math classes Northwest Ohio. For the interview, I recruited 12 students (6 males, 6 females) from a public school in Northwest Ohio. Of these 12 students, the sample will be further divided into students in advanced STEM (N=6; three males, three females), and non-advanced STEM (N=6; three males, three females). This purposeful sampling strategy helped provide a range of experiences with STEM, which helped with the comprehensiveness and transferability of the findings. Twelfth-graders were targeted because they are in a transitional phase as they approach graduation and potential careers or college majors. According to the National Science Foundation (NSF), “the drop-off in the study of science among women is extremely steep from the high school through Ph.D.” (as cited in Bart, 2000, p. 247). Because of they are in a transitional period from high school to college, I expected they would have more awareness of their future goals and choices than younger students.

Approval, permission, consent, and assent were acquired in the appropriate sequence. First, I acquired approval from the University Of Toledo Institutional Review Board (IRB) to ensure the study is ethical. Second, I acquired permission from the two school boards. Once school board permission was acquired, I gained permission from the

science and math classroom teachers whose students I interviewed. Finally, because some of the students were minors (under 18), I needed parental consent as well as participant assent for those students. The appropriate explanatory letters and forms were used to inform all the involved groups and document the signed consent and assent. I coded all participants by case number and gender, rather than name.

### **Data Collection**

The data were collected using a phenomenological approach. This section discusses the details of the instrumentation and procedures that will be used, which will include two rounds of interviews and a follow-up discussion.

### **Instrumentation**

The data collection instrument was two one-on-one 60-minute interviews about the lived experiences of the participants. After the initial meeting for consent/assent and the two interviews, a fourth meeting occurred for follow-up and clarification from the interviews, called member checking, in which I double-checked the participants' perspectives on the credibility and validity of the findings and interpretations based on the recommendations of Creswell (2007). This member check lasted about 30 minutes. These interviews were scheduled with the students during their study hall or homeroom periods during school so that the interviews did not interfere with their curricular or extracurricular activities.

The two interviews were open-ended, semi-structured, and conversational. The first interview focused on some background and personal preference questions, beliefs about peers' abilities, and beliefs about how teachers influence gender. The second interview focused on gender differences in STEM careers, family and peer influence on

gender beliefs, and media influence on gender beliefs. The follow-up member-checking meeting clarified any vague points or responses from the interviews and to give the student interviewees the opportunity to add or change any response.

### **Procedures**

The data was collected using sequential triangulation, which means each round of data collection occurred one after the other, and the data will be analyzed separately. After analyzing the data separately from each interview, the results of this analysis were compared between the different interviews and between the participants. The procedure is considered triangulation rather than transformative or embedded because the analyses were separate. Finally, the results of each separate analysis were compared and cross-analyzed to determine commonalities, differences, and exceptions in the findings as the larger themes emerge.

### **Data Analysis**

The information about experiences with the myth of gender differences in STEM among 12<sup>th</sup> grade males and females gathered from the two rounds of interviews and the follow-up were analyzed qualitatively through a feminist lens. The strategies I used to analyze my data included the following steps:

1. I quoted each transcript in relation to each code and them in one box.
2. I separated the quotes by code in a new word document paper to work with.
3. I printed the quotes then I read them and highlighted the important words.
4. Organized my ideas into a spreadsheet.



5. I found the common findings and put some examples quote from the quotes I have from the box.
6. Finally, I put all of the themes together.

I used the ATLAS.ti qualitative analysis software and to analyze and manage the data throughout the coding process within the software. The qualitative data was semi-quantified by creating codes and themes qualitatively, then by counting the number of times they occur in the interview data. However, most of the analysis was qualitative and focused on quotes, patterns, and themes.

### **Summary**

Chapter 5 explained the methodology used in this study. The methodology was based on qualitative methods, including both one-on-one interviews and a follow-up meeting. The sample from which this data was 12 students in 12<sup>th</sup> grade in STEM high school courses in Northwest Ohio. These methods addressed the purpose of exploring the experiences and perspectives of 12<sup>th</sup> grade male and female students in relation to the myth of gender differences in STEM, and to what extent they aligned with the myths and stereotypes promoted in society.

## Chapter Six

### Results

Based on the interview data collected from the 12 students (six males, six females) from the 12<sup>th</sup> grade, I organized their responses by code and summarized the findings as presented in this chapter. The findings are organized by a summary of the cases and demographics followed by preferences, perspectives, and beliefs about self, peers, parents, and media.

#### Overview of the Cases

This interview-based qualitative phenomenology study included six males (three advanced STEM and three non-advanced STEM) and six females (three advanced STEM and three non-advanced STEM in high school) from 12<sup>th</sup> grade from one school in Toledo. The 12<sup>th</sup>-grade student population of the school is 297 divided into 148 female students (50%) and 149 male students (50%). Table 1 summarizes the demographics of the cases.

Table 1

#### *A Brief Summary of the Demographics of the Cases*

Case	Age	Gender	Level
Case 1	18	M	Non Advanced
Case 2	18	M	Non-Advanced
Case 3	18	M	Advanced
Case 4	18	F	Advanced
Case 5	17	M	Advanced
Case 6	17	F	Non-Advanced
Case 7	18	M	Non-Advanced
Case 8	18	M	Advanced
Case 9	18	F	Non-Advanced
Case 10	17	F	Advanced
Case 11	17	F	Non-Advanced
Case 12	18	F	Advanced

The students were between 17 and 18 years old. When asked about their favorite subject, five out of six males said their favorite subject was STEM and one out of six females said their favorite subject was art and social studies. All six males stated that they think about themselves as good in STEM, but four females reported they are good at math and all of them think they are good at science.

### **Self-Preferences**

When asked about enjoying math, all males reported enjoying math, but just three of the females reported enjoying math. In science, all males and females indicated they enjoy the subject.

For three males and three females, their favorite teacher in math is male, while an equal number reported their favorite teacher in math is female. In science, however, most males (5:6) indicated their favorite teacher is male, while four out of six females reported having a female as their favorite science teacher. So in math, the male and female preferences are divided evenly between male and female teachers, while in science the males prefer male teachers and females prefer the female teachers. From the other perspective, most students did not see any of their teachers as showing a gender preference in STEM.

When it comes to who performs better, the females felt the males and females are equal, but the males thought the females perform better in math class. In science, the females thought the females perform better or the same as males, but the males think that males perform better or the same in science class.

As for more participation, in math the males felt the males are better or the same in participation and female thought the females have better or the same participation as

males. In science, males thought the males are better or the same in participation and females thought the females have better or the same participation.

### Gender Differences in Performance

Overall, the students who participated in this study did not have a clear belief that one of the genders is better than the other in math or science classroom performance. In other words, the results were almost equally mixed between believing males are better and females are better. Table 2 shows the results of the responses to questions about classroom performance.

Table 2

#### *Responses to Questions about Gender Differences in Classroom Performance*

Case	Gender	Math	Science
Case 1	Male	Same	Same
Case 2	Male	Female	Male
Case 3	Male	Male	Same
Case 4	Female	Same	Female
Case 5	Male	Male	Same
Case 6	Female	Same	Same
Case 7	Male	Female	Male
Case 8	Male	Female	Male
Case 9	Female	Same	Female
Case 10	Female	Male	Female
Case 11	Female	Female	Male
Case 12	Female	Same	Same

There are five cases who think that males and females are the same in their performance in math class: Cases 1, 4, 6, 9, and 12. Case 1 (male) said, “There is not much difference or there is an even mix.” Case 4 (male) said, “They are pretty equal,

maybe because have been with same people and same math class for four years...I think they are pretty equally intelligent and they equally know what they are doing.” However, Case 4 added that “the males are more sure [sic] about themselves.” Case 6 (male) said, the genders are equal, adding that “there are a lot of talented boys and girls in my school. It depends on how much effort you put in.” Case 9 (male) said, “We have males that are struggling and ask females to help them and we have females that are struggling and ask males to help them.” And Case 12 (male) said, “I don’t think there is very much of a difference. They are pretty close. Today, there is motivation and performance changes.”

However, there are four (three males and one female) who thought that females perform better than males in math class (Cases 2, 7, 8, & 11). Case 2 (male) said, “They just seem to have the answer and know everything better.” Case 7 (male) said, “Females are slightly better and understand it better and perform better.” Case 8 (male) stated, “The best grades in my school are achieved by a female. She is really good at it, in tests and stuff, she has 100% understanding. . . . In math, females are more focused in school work and males are more outward.” And Case 11 (male) said,

Females work harder. . . . I’m not sure why they are better maybe because they take advanced chemistry and advanced physics. . . . Females work harder and they know that it is going to be on the test or perform in the lab test. Females care about their scores more than boys. . . . I think the difference is that the females know that the classes they are taking will affect them for the future. The males are taking the class just to graduate.

In contrast, there were three cases (two males and one female) who thought males perform better in math class (Cases 3, 5, & 10). Case 3 (male) said,

They seem to understand things more easily at first, especially in math. For example, in calculus we learned how to calculate the volume of abnormal shapes and it seems that males were better visually. I think that females often have more of a drive to study and eventually learn things as well as males in mathematics. Both males and females usually average about the same on the tests. In the end, I guess usually males get it first then females end up getting it right as well. I think they [females] work with a better ethic.

Case 5 (male) said, “In my class, females ask more questions. It seems they don’t understand as well and need more explanations.” Additionally, Case 10 (female) said,

That is how their brain works and what makes sense to them. Males are more comprehensive and emphasize hard facts—two is two and four is four—and females do more abstract things, just about how their brain works. . . . Big concepts make better sense for them. The boys are ok, nothing is wrong, but most of the time girls. . . . They end up answering the questions more and they respond to the teacher more. The females don’t answer more, but they ask questions more so they can understand it more. . . . In science, the males think about yes or no answers. Science has a lot of gray areas and females are better able at understanding gray areas.

There are five cases (four males and one female) who reported the belief that males and females are the same in their performance in science class (Cases 1, 3, 5, 6, & 12). Case 1 (male) said, “There is not much difference.” Case 3 (male) said “It seems to be similar in math. Girls are better at tests that are about memorization in science, but boys seem to do better in the labs because it seems like they can apply their knowledge

better.” Case 5 (male) said, “I have a lot of friends in my science class who are really smart. There are girls who are really smart in science class, and actually I go to them to ask them to help.” Case 6 (male) said, “They are very equal because I know girls who are very talented in their science class and also I know boys that are very talented in their science classes.” And Case 12 (female) said, “We don’t have many differences in people. Most of the time the highest scoring people are both girls and boys.”

However, there are four cases (three males and one female) who reported thinking the males perform better in science class than females (Cases 2, 7, 8, & 11). Case 2 (male) said, “All of my classmates in astronomy are male and they are engaged and involved, [but] the girls are taking it just because it is a science class.” Case 7 (male) said, “The males are a little bit better.” Case 8 (male) said, “Because the females don’t care about it or they struggle more with it.” And Case 11 (female) said, “I’m not sure why they are better, maybe because they take advanced chemistry and advanced physics.”

However, there are three female cases who thought that females participate more in science class (Cases 4, 9, & 10). Case 4 (male) said, “We have a very, very brilliant girl. Most of my AP classes are girls. I see the girls perform better. They work harder and they are more perfectionist.” Case 9 (male) said, “Females get more involved in it and males take more time to think about it.” And Case 10 (female) said, “The concept make better sense for them. The boys are okay, nothing is wrong, but most of the time, girls participate more in science.”

### **Gender Differences in Participation**

In regards to gender differences in classroom participation, there is no clear difference based on the responses of the cases. The results were roughly equal in

comparison between males and females. Table 3 shows the results of the responses to questions about classroom participation.

Table 3

*Responses to Questions about Gender Differences in Classroom Participation*

Case	Gender	Math	Science
Case 1	Male	Female	Female
Case 2	Male	Same	Male
Case 3	Male	Same	Same
Case 4	Female	Same	Female
Case 5	Male	Same	Same
Case 6	Female	Female	Same
Case 7	Male	Same	Male
Case 8	Male	Male	Male
Case 9	Female	Female	Same
Case 10	Female	Male	Female
Case 11	Female	Female	Male
Case 12	Female	Same	Same

The half of the cases reported that males and females are the same in participation in math class (Cases 2, 3, 4, 5, 7, & 12). Case 2 (male) said, “Because the class is about 50/50, when the teacher calls on somebody, no one wants to give an answer.” Likewise, Case 3 (male) said, “Both seem equally involved.” Case 5 (male) said participation is “about the same, 50/50, raising their hands and answering questions.” Case 4 (male) said the participation is the generally the same, but “the girls ask more questions and the boys answer more questions and make more statements.” Similarly, Case 7 (male) said, “Both participate equally, but women are more confident.” And Case 12 (male) said, “Their participation is about the same in asking questions.”

There are four (three females and one male) who believed females participate more than males in math class: Cases 1, 6, 9, and 11. Case 1 (male) said, “Females participate in the [learning] process more than males.” Case 6 (male) said, “Girls



generally do [participate more] because they take it more seriously than boys. Girls usually have more maturity in high school than boys, so they're less likely to goof off." Case 9 (male) said, "Females participate more and males don't care." And Case 11 (male) said, "Females work harder and do the whole picture and they have to do this in the test and boys do this because of the class."

But Cases 8 and 10 reported that males participate more in math class. Case 8 (male) said, "Males talk more and are more vocal, and females are more quiet." and Case 10 (male) said, "They [males] end up with the answer to the questions more and they respond to the teacher more. The females don't answer as much, but they are ask questions more so they can understand it more."

In science class, Cases 1, 4, 10, and 11 (three females and one male) shared the lived experience that females participate more than males. Case 1 (male) said "Females answer more questions than males." Case 4 (male) said, "When I was in chemistry class, the boys participate more, but in biology, we don't have many boys in class so mostly girls [participate]." Case 10 (male) said, "They [female students] answer teachers' questions and respond to the activities more, and the males are better at asking questions." Finally, Case 11 (male) said, "Females work harder and they know that it is going to be on the test or perform the lab on the test. Females care about their scores more than boys."

However, Cases 2, 7, and 8 stated that males participate more in science class. Case 2 (male) said "Like the topic in astronomy we have just 7 girls in class." Case 7 (male) said "They have more hands on and with the stuff. They might understand it little

bit more and they are not afraid to answer.” And Case 8 (male) said “Males are more interactive.”

### Perceived Gender Differences in Teachers

Very few cases had preferences about the gender of their teachers in math and science. In other words, the results showed that the students do not care much about the gender of their teachers. This indifference is the case for math slightly more than science, but there was no strong preference in either subject. Table 4 shows the results of the responses to questions about teacher preferences.

Table 4

#### *Responses to Questions about Gender Differences in Course and Teacher Preferences*

Case	Gender	Preference		Better		Favorite		Teacher preference	
		Mth	Sci	Mth	Sci	Mth	Sci	Mth	Sci
Case 1	M	No	No	Same	F	F	F	Yes	No
Case 2	M	No	No	Same	Same	M	M	No	Yes
Case 3	M	No	Yes	M	M	M	M	No	Yes
Case 4	F	No	No	Same	Depend	F	M	No	No
Case 5	M	No	No	F	Same	F	M	No	No
Case 6	F	No	No	Same	Same	F	M	No	No
Case 7	M	No	No	Same	M	F	M	No	No
Case 8	M	No	No	M	M	M	M	No	No
Case 9	F	Yes	No	F	M	F	M	No	No
Case 10	F	No	No	M	F	M	F	No	Yes
Case 11	F	No	No	F	F	F	F	No	Yes
Case 12	F	No	No	Same	Same	M	M	No	No

Most of the cases, 11 out of 12, reported that they do not have any preference for the gender of their math teachers. Only Case 9 (female) said she had a preference, which was in favor of female math teachers. She said, “Females make sure to go through every step with you to see that you got it. They involve students more, and males think if you don’t get it, you are stupid.” Similarly, all but one case stated that they do not have any

preference of science teacher. Only Case 3 (male) said in science class he prefers “males, because the best teacher I have ever had is a male.”

Half of the students shared the experience that math teachers are the same (Cases 1, 2, 4, 6, 7, & 12). For example, Case 1 (male) said, “It depends on the material if they can explain it well and teach it well.” Case 2 (male) said, “If they can do their subject, it doesn’t really matter—male or female. The teacher is all about teaching the subject matter.” Case 4 (male) said, “It depends on the individual. I don’t think it matters if it is a male or female teaching, it is just a matter of how experienced they are and how much they care about teaching this subject.” Case 6 (male) said, “They are equal; they both know what they teach. There is no difference.” Case 7 (male) said, the genders are “equal, but I didn’t have a male teacher in my history for math.” And case 12 (male) said, “I had good and not-good teachers, just from the teachers I have had, [and both] male and female.”

But there are three cases (two males and one female) who think male students are better in math (Cases 3, 8, & 10). Case 3 (male) said, “In general, I don’t prefer a certain gender; I just prefer a certain teaching style. I have had both male and female math teachers that I have liked a lot. However, I have had more male math teachers that I liked than female math teachers that I like.” Case 8 (male) said, “It doesn’t matter—male or females teaching me—[but] I have just had some very good male teachers.” And Case 10 (male) said, “From my just personal experience, I say male. I had two male teachers, and they are very good at math.”

The other three cases (two females and one male) think the female teachers are better: Cases 5, 9, and 11. Case 5 (male) said he prefers math teachers who are “female,

because we are used to it.” Case 9 (male) said, “Females make sure to go through every step with you to see that you got it. They involve students more, [but] males think if you don’t get it, you are stupid.” Finally, Case 11 (female) said, “Female teachers are better because they explain all the steps thoroughly.”

Cases 2, 5, 6, and 12 reported that male and female science teachers are the same. For example, Case 2 (male) said, “It depends on the class: females understand science better with a female teacher and males understand science better with a male teacher.” Case 5 (male) said it is “the same, because I have had great science teachers that are males and females.” Case 6 (male) said it does not matter, “As long as they know what they talk about and they are very intelligent.” And Case 12 (male) said both genders are “the same; neither one is better over the others just because teachers I have had. I had both good and bad teachers.”

Cases 3, 7, 8, and 9 (three males and one female) thought males are better. Case 3 (male) said, “Because the best teacher I have is a male.” Case 7 (male) said, “They teach to my learning styles a little bit better and more visual and hands on.” Case 8 (male) said, “Male he is very interactive in class and in explaining stuff. He seems more able to talk to students on an equal level. I think this is important when teaching.” And Case 9 (male) said, “Male teachers are really excited about science.”

The other three cases (two females and one male) think the female teachers are better. Case 1 (male) said “They are very direct to the point.” Case 10 (male) said, “I had better experience with female teachers. I have had many female teachers who have explained to me and made sure I understood the subject. However, I have a male math teacher right now and he is easy to understand and to follow a lot. He answered all my

questions.” And Case 11 (female) said she prefers “females because they are thorough and willing to work with you. The male teacher I had was terrible.”

There is just one case who thought that it depends on the individual. Case 4 (female) said, “It depends on the individual. I don’t think it matters if it is a male or female teach, it just matters how much experience they have and how they care about teaching this subject.”

Most of the cases stated their favorite math teacher is female (four females and three males). For instance, Case 1 (male) said she prefers math teachers who are female, and in the past when she had female teachers, she said, “I understood everything well and performed well.” Case 4 (female) said her favorite math teacher is female “because she knows more about math and she worked so hard to make sure all students know what they doing.” Case 5 (male) said his favorite teacher was a “female; I remember her teaching methods are the best.” Case 9 (female) said, “Females. . . . are more understanding about things.” And Case 11 (female) said her favorite teacher was “female [because] she helped me during lunch study hall.”

Most cases, 9 out of 12, stated their favorite science teacher is male (four females and five males). Case 2 (male) said “Male, my astronomy teacher used to play hockey and make joke with the males.” Case 3 (male) said, “Male, not because he is the best teacher; I can just relate to him well.” Case 4 (female) said, “My chemistry teacher is a male and he knows more about science and he cares the most.” Case 5 (male) said his favorite science is a “male; he is very funny and incorporates science in to his jokes.” Similarly, Case 6 (female) said, “Male, he interacts with his students more and he teaches one of my favorite subjects.” Case 7 (male) also said his favorite science teacher is

“Male, he was teaching astronomy.” Case 9 (female) said “he understood everything and gave great examples and great extra help.” Finally, Case 12 (female) said her favorite science teacher is a male who “has been teaching for a very long time and he knows what he is doing.”

Cases 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and 12 reported no math teacher preference of gender. Like Case 2 (male) said, “No, my math teacher has known my mom since I was only 8 years and would welcome me when I came to class. She calls on people the same amount and she didn’t show any kind of preference to me.” Case 3 (male) said, “No, he is a very fair guy.” Case 4 (female) said “No, preference.” Case 5 (male) said, “No, he calls every one equally.” Case 6 (female) said, “No, my current math teacher has been around for so long that she sees the good and bad of both genders and knows that it comes down to what they are saying.” Case 7 (male) said, “No, she is pretty easy.” Case 8 (male) said, “No, I don’t see any one preferring males or females.” Case 9 (female) said, “No, she treats everybody equal.” Case 10 (female) said, “No, pretty equal. If you don’t understand the teacher will help you.” Case 11 (female) said, “No, my math teacher treats us as equals.” Case 12 (female) said, “No, he treats every one equally. They are pretty approachable.”

There is just one case who said there he experienced teachers showing a gender preference in math. Case 1 (male) said, “Yes, some of them have gender bias towards males and females. Male [teachers have a] bias for males and females a bias for females. I think because they think the same way because they are the same gender. Both male and female teachers I have had in the past have shown some genders bias.”

Most of the cases, 7 out of 10, stated they experienced no teacher gender preferences in science. Case 4 (female) and Case 5 (male) said, “No, preference.” Case 6 (female) said, “No, because he knows that both genders are capable of doing well, so he treats them the same.” Case 7 (male) said, “No, they are equal.” Case 8 (male) said “No, I don’t see any one preferring males or females.” Case 9 (female) said, “No preference.” And Case 12 (female) said, “No, she treats every one equally. They are pretty approachable.”

There are four cases who said yes there is teacher preference in science (two males, two females) and one case who said it depends on the individual. Case 2 (male) said he has a male teacher who

. . . jokes with males and he knows the males will not be upset about his jokes. He doesn’t joke with females because they might be upset about his jokes. But he doesn’t ignore females, he just doesn’t make fun of them.

Case 3 (male) said, “Yes, I think he preferred boys a little more than girls. I think this is because he grew up with a son and he likes sports. [However,] I don’t think his preference affects his ability to teach both genders equally.” Case 10 (female) said, “I think he prefer the girls just because how their mind works.” Case 11 (female) said, “my science teacher prefers females more than males just because she knows that they work harder.” Finally, Case 1 (male) said his science teacher shows “no bias towards gender; [however,] it depends on the person.” Table 5 presents additional perspectives from the cases they have about teachers of different genders.

Table 5

*Responses to Questions about Gender Differences and Similarities in Teacher Behaviors*

Cases	Differences	Similarities
Case 1	Females tend to go more in depth	Both are very direct to the point
Case 2	Males make more joke, stick to the subject, and don't deviate.	Both teach the same subject matter
Case 3	Males seem to explain things using relatable concept Females stick to the book more.	Care for their students in the same way. Both make sure they teach the material well and the students understand it.
Case 4	Males tend to be more difficult; Females are more companionate and they are nicer to students	Their knowledge in their subject
Case 5	Males are sarcastic and funny; Females start for the point and try to stick to a schedule.	Both cover the same subject, have lesson plans, and try get to certain topic down that day.
Case 6	Males generally joke around, understand their students more, and make it more fun; Females tend to be more a little more distanced than males.	Both genders want their students to succeed so they really trying to help. They are both gender are intelligent.
Case 7	Females follow the textbook order more	Both teaching from the book
Case 8	Males focus less and are more aloof; Females focus in their teaching	Both teachers are friendly but each teacher has their own teaching style.
Case 9	Males think if you don't get it you are stupid, are really excited about science, and are more straightforward; Females beat around the bush, are uncertain, but are involved and go through every step.	Both males and females teachers are passionate about their work.
Case 10	Males lecture; Females use more activities	Both science teachers genders are usually adaptable
Case 11	Males teach to get the paycheck; Females do it because they love to teach the subject	Both teachers are academically strong and they go through the hardest math.
Case 12	Different kind of presentation. Female teachers may have more conversational presentations.	Both are equally capable in getting concept through to students.

The cases believed the biggest difference between male and female teachers is that male teachers make more jokes and generally joke around with their students. According to



the interview, male teachers seem to understand their students more and make their classes more fun. They seem to explain things using relatable concepts, tend to be more difficult, sarcastic and funny the male teacher are less focused in their work. The cases reported males are more aloof but really excited about science.

In contrast, in general the cases described female teachers as less straightforward than males, more serious, and are more uncertain about their answer, and like to set the students down and lecture them. And they have different kind of presentation. The cases believe female teachers explain the content and materials in a more organized way. Additionally, females tend to go more in depth stick to the subject, do not deviate, and stick to the book more. One student (Case 3, male) said, “From my experience, [female teachers] follow the textbook’s order, like writing things down and coping notes.” The cases generally agreed that female teachers start on the point and try to get things in agenda done. Female teachers are more focused in their teaching and made sure to go through every step with you to see that you got it. They are more companionate and they are nicer to students. They involved the students more. The females like to make activity more they do it because they love to teach the subject and they have more conversational presentations. However, a few students said they thought female teachers tend to be more a little more distant than males.

In STEM, the students stated both male and female teachers are generally the same. For example, Case 8 (male) said, “both teachers are friendly, but each teacher has their own teaching style.” The cases believed the biggest similarity between male and female teachers in STEM is both are very direct to the point, teach the subject matter, and care for their students in the same way. They actually made sure that they were teaching

the material well and that the students understand it. Both genders use their knowledge in their subject. Both cover the same subject, have priority plan, and try to get a certain topic done that day. Both genders want their students to succeed so they really try to help. The cases agreed both genders are intelligent in their area of expertise. They are teaching from the book and passionate about their work. Both try to explain to make sense to them first, and then if that does not work, they try to explain it in a different way. They are both equally capable in getting concept through to students. Male and female teachers are academically strong and they go through the hardest math.

### **Role Models in Math and Science**

As the above memo notes, 9 of the 12 cases thought of a female scientist, but none of them could think of a female mathematician. The most common female scientist was Marie Curie, with all nine students mentioning her. They had just learned about her in class. None of the students mentioned a different female example. As for examples of female characters in the media who are scientists or mathematicians, most of the cases had difficulty thinking of one. One of the students, a female student, thought of an example of a female character in the media who is an expert in math and/or science. She mentioned a character named Happy Quinn, a genius mechanical engineer in the television series *Scorpion*. She is a female, Asian-American engineer, and the student said, “She is a good role model because it is not often expected that a women can be an engineer, but she is good at it” (Case 12). A male student (Case 2) thought of the example of Sandra Bullock’s character in the movie *Gravity*. One male student, Case 8, could not think of a female at first, but then mentioned Amy Fowler from *The Big Bang Theory*. Case 11, a female, mentioned Angelina Jolie, Robin Roberts, and Diane Sawyer as

positive female role models who are not scientists but sometimes promote scientific research and causes.

In contrast, the students were able to think of a few different examples of male mathematicians or scientists. None of them said that they did not know any male examples. Most of the students mentioned Albert Einstein. Another common example was Sir Isaac Newton. In the media, Stephen Hawking, Neil DeGrasse Tyson, Bill Nye, characters from Big Bang Theory, and various male action heroes who are scientists. Two students mentioned that “there are a lot” of male examples, but then they had trouble thinking of one at the moment.

One of the male students, Case 2, explained how he thought media affected the disparity between men and women in science, “I don’t think the media is really about the women I don’t think they talk about it there is no female Einstein, not that there is not one out there they just don’t get talked about.”

### **Peers**

Most of students said friends are affected by peer pressure second to the influence of family but more than media. Most had examples of friends affected by peers, but not themselves. Just two students said, “I don’t think it affects it at all” (Case 2, male) and “I don’t think that pressure of friends or peers make as much different in career field” (Case 4, female). Most other students said friends and peers have a “huge effect,” “big part,” “big factor,” “effect,” or at least have a “little effect,” and “encourage” their friends.

There are some examples of how friends affect each other. For example, Case 1 (male) said, “I feel like my peers affect me more than my family.” Additionally, Case 5 (male) claimed, “For me they affect me a little bit I kind of wanted to do engineering.”

Some students think the peers or friends affect other and their choice when they are very young at high school or earlier. Case 11 (female) did not say peers affected her, but they did affect her brother: “My brother probably goes with his friends because he is younger and he doesn’t know yet.” Case 3 (male) also said, “The peer belief is what goes way back before high school.” And Case 5: male, “I think people, especially in high school, follow their friends and what their belief is. . . . They kind of do what their friends do and want to be in the same class as their friends.” In contrast, Case 6 (female) thought differently than the other students about peers affecting their friends in high school. She said, “I don’t think it affects them so much, especially in high school.”

Seven students think that family affects preferences more than peers. There are only two cases who think the peers affect more than the family. The two who disagree with the majority used their self or their friend or brother as examples affected by their peers. For instance, Case 1 (male) said, “I feel like my peers affect me more than my family in certain cases. It really depends on how strong your family tries to get their child to do something. I think peer influence is more relaxed and peers listen to each other more.” Case 10 (female) said,

I think in this point it is my peers [who are more influential], because in high school, you are kind of looking to think and act outside your parents influence. It is your stage where you are kind of exploring the world that is outside your house. So I think that you’re really trying to listen to your peers more rather because you already know how your parents think at this point.

Also, Case1 (male) stated, “If a peer decides to go into a certain field, then their friends may feel the influence to go into that field as well.”

Some students think the same gender has more influence than the opposite gender. Case 10 (female) asserted,

I think the same gender is definitely more influential than the other gender. [I have] seen people who have significant others, like if a girl has a boyfriend, they still like to rely on her other girlfriends more than the male because they might be close but there's still a difference in gender there and just the way the mind thinks and [fellow] females are more reliable then. I think females with females have more peer pressure than males than males because females have a tendency to talk more about things like that, males I know they don't really talk about things that are going on they might talk about sport or whatever, or whatever guys like to talk about but females are more I think more prone to talk about concerns that they have.

Case 3 (male) reported,

I think in general people view that boys are better at science just for whatever reason. I just disagree with it; I just don't attest to it. I just kind of let it be said I guess. I do not give my opinion about it if something is brought up by my friends, I just take it for what it is; it's not like they insulting the girl, they are just making a joke; [however,] when people make jokes, they believe in it a little bit.

In general, these cases feel peers have a strong influence, but the individual still has the power to accept or contest the peers' influence. These quotes reveal how the cases navigate both their peers' influences to establish a somewhat independent identity.

## **Family**

Most of the cases said their parents and family do not talk about gender differences. There are two students who said yes: Case 5 and Case 10. Case 5 said, My parents: sometimes they do [talk about gender], yes. . . . Like there are females that are more caring and my mom works in early childhood so there would be like no males in her office. . . . They would be all females. [And] my parents talk about how there is more males in [my dad's] work. My dad works in a warehouse and there are more males moving around boxes and there are more females at my mom's work at her job. I think my dad mainly says the warehouse is for males who can lift boxes and the females can't pick up large loads. My mom says females are more nurturing and able for child and for what I think influences for them to go towards education and you know like child care.

Case 10 (female) said her family does not discuss it, but "some families do." Nearly all student agree with their parents and family and they said don't see them talking about gender differences in front of them and treated them equal if they have siblings.

All students think the families have more influence on students' choices about their major and career than peers and media. There are nine cases who said that families have "strong," "the most," "much," "a big," and "a lot of" effect on the students' choices. Two of the students said family just has an "effect" on their kids, with no qualifying words like "the most" or "a lot". There is just one student (Case 10, female) who said,

I think it depends on like what stage of your life you are in. When you are a child, I think that your family is more likely to affect you, but as you get older, like say

you go off to college and you're not at home anymore, you're peers are definitely more influence on you.

So the influence of parents versus peers on their gender perspectives may depend on the developmental stage of life they are in.

When I asked them why they think the way they do, some of them, like Case 6, said, "Because deep down every kid wants to make their family proud of them and if they do something that their family would look down on then they just don't want to it anymore." Case 5 said parents have a big influence "because they are the ones that support you." Case 2 explained that he is affected by his dad and told a story about how they were playing together building things and that affected his interest in how to build things "ever since I was a kid." Case 7 gave a possible explanation for why family has a strong effect: "Family affects one's decision in which career field to go in most because you are closest to them and they mean the most to you."

Some students gave examples of their friends and people they know in which their families pushed them to a major or career. For instance, Case 1 said his friend's parents are pushing him to go into engineering. He added, "I am not sure if that is what he wants to do himself. They are always talking about it around him and have conversations with him about it." Similarly, Case 8 said "one friend of mine's family owns business and he has been pushed into working with them." Case 5 also gave example about his friend: "My friend's father wants him to go in to engineering because that's what he does for a living." Case 4 told about her friend's family who affected her decision to be a doctor: "One of my friends, in her family everyone is a doctor and she want to be a doctor since day one of her life. So her parents put pressure on her to do

really well in school and programs, so [they're] pushing her in that path." It appeared to be easier for the cases to tell stories about their friends and peers being influenced by family more than themselves. Perhaps they lack the outside perspective to see how they are influenced, but it is easier to see it in others.

One of the students, Case 5, thought the males in the family affect the other males more than the female, and likewise the females affect the other females more. For example, the dad will encourage his son to pursue "a sport they want the male to do. Or the female: the mother would want to follow the mother's footsteps." He said, "Sometimes fathers will encourage their sons to pursue careers similar to their own. The same goes for mothers and their daughters." However, he went even further to claim that "The male follows the father's footsteps more than the female follows her mother's footsteps."

### **Media Effect**

Most cases, when they talked about media, said there are more male scientists than females. Additionally, there are more female teachers than male. The general opinion was that the media showed males as being intelligent but the females as dumber in science. Case 3 said if the media shows a female as intelligent as a male, they will still show the female as the assistant for the males. Some of them gave examples: Case 1 and Case 3 (males) think that media shows females as the dumb or ditzy blonde girl asking stupid question and male as the doctor or the mathematician. Other cases said that the media shows males as doctors, scientists, mathematicians, and the intelligent characters all the time and females as a teachers, assistants, organizational, and caretaker careers. Case 1 male said,



For example, in Big Bang Theory, the males on the shows are doctors, and the females are some of the doctors, but it leans on the male's side being doctors. It shows that males are doctors and females aren't that it shows that the males are more advance in that field. They show it because the shows I seen that deal with that females are usually showed as being intelligent but I don't see many of the females that are more dumb in science.

However, Case 3 said about media, "You always see the ditzy blonde girl asking stupid question or the girl in the math class asking stupid questions like that. You always see the scientist is a male in most movies, the mathematician is always a male in most movies, and the genius is usually the male in most movies. I see that a lot and I don't think that there is a movie that there is a star that is a girl that is super smart, so I see it all the time." The only student who thought the males and females in the media are equal was Case 2. He said, "In TV they're mostly equal I think. None of them really pick on the other gender. I mean even the movie Gravity had Sandra Bullock in it."

Case 7 (male) reported thinking that the media takes this stereotypes from our lives. He said, "Usually you see female teacher or male scientist or something like that."

Case 8 (male) said "I think in every movie a scientist is a guy I think I have never seen too many girl scientists." Case 9 (female) said, "In a lot of movies, they portray men being smarter than women. They make the man more dominant than the women, and TV shows as well. They kind of don't portray the women as being smart or successful at all."

Case 10 female said "In movies and TV, there is definitely a bias towards man being scientist and being a mathematician and women usually are starting to be interested in science, mostly the field of biology, but the men are still the dominant face." Case 11

female said, “Like with boys and STEM, it seems like boys in movies and stuff they always they want to crack the crime and the government things and using the technology and science and math.” Case 4 female said, “Almost always the scientists are men and the heroes are generally are men. . . . Once in a while there is a powerful female, but generally it’s men.” Case 12 said, “Women are often shown in organizational and care careers more than men. I have seen a stereotype of men being in more of the mathematical or science role. The females are usually portrayed as less interested in those fields.”

Some cases think the media takes this stereotypical gender picture from the past. Case 6 (female) thinks the media reflects the 1960s and not our lives today. She said, “I think that when they [the media] get their gender stereotypes and gender differences, [they get it from] the 1960s and prior to that, back when the stereotype were very pronounced.” However, Case 5 said some of the trends still exist in reality today. He said, “I think a lot in the media they have a doctor or like certain stereotypes because certain jobs like a doctor are usually a male. The teacher in the movies is usually a female, as teachers are mainly females. I think that is kind of what stereotypes are reflected in the media and used in the media.”

Nine of the cases believed the STEM gender differences in the media are mostly false. For example, Case 1 (male) said, “Just because if it is in TV shows, it doesn’t mean they have proof that is the case in real life. In reality you could go either way, depending on the person.” Additionally, Case 3 (male) said,

I personally know that some of the women are great at STEM. You know that just alone proves that it is wrong not to mention that like behind the scenes like even

the past hundred years ago when it was frowned upon women to be doing science, it was still doing it just males were getting credit for it. . . . They would do research and they would put it under a males name so it could be taken credit for it seriously, and even today a big portion of professors are science and mathematician are women.

Case 4 (female) said,

I don't know why they do the way they do it but I know they are tons of women in scientific fields are there and there are plenty of women who are doing well on their own and have successful careers. And of course there are men that have that, too. It's just more accepted and more common to show men. Well, I think the media is contradicted by all of the women who are in the science and math field and who are successful and who are doing things.

Case 8 (male) said "because they show a lot of guys in science. They do have it right as more as there are guys in science, but I don't think that media means that they're better at science and math."

Case 9 (female) said,

The movies are the extreme stereotypes they are not truly based off of reality. People who make these movies spend reality to fit whatever scenario they want to portray. . . . The stuff that exists [in reality] contradicts that. Just look around nowadays: women are working in factories where it was predominant men 20–30 years ago. I still think gender difference still exist; they are just not as pronounced. They are still slowly going away, but they are still there.

Case 10 (female) said,

In real life, you see women you see them being successful and going to grad school and being nurses, being doctors. Some guys don't do that and some guys are stay-at-home dads . . . and I feel like that contradicts the media or reality

Case 11 (female) said,

[The media] is not an accurate representation of every single the way life is and every single setting. I think it's false because the girls like that of a certain movie. I think one thing that definitely contradicts the media is, [for example] this coming year, the valedictorian and salutatorian, they are both girls and they are both going to STEM field. And so both of those girls show it's not as it seems in movies. It is how driven they are, you barely see a women doctor, I mean they do exist, but in the movies you don't see women doctors and you even don't see a women scientist you see; it's always a man.

Case 12 (female) said, "I think that I have seen men and women in jobs that are the opposite of what the media or TV portrays."

There is only one case who thought that the STEM gender stereotypes in the media are both true and false depending on the case. Case 7 (male) said,

I will say there are some true and false [media depictions]. I think a lot of time the T.V and the media portray, as you see, like stereotypes, like girls mostly do this and the guys mostly do that. But I think that is true and there are some occupations and fields that are mostly women—mostly man in one or women mostly in one—but I think it is changing. And it's also false because I see women changing and going in different fields as men. The media mostly portrays females

in certain field of math and I have seen the opposite. I have seen women in fields that are mostly men in it and I have seen man in field mostly women in it.

In general, the cases perceived the media as favoring males in math and science fields.

However, there are two cases who think that STEM gender differences in the media are mostly true. For instance, Case 2 (male) said the reality is actually demonstrates more of a difference in careers than the media depiction. He said,

I think they [the stereotypes] are mostly true; I mean they split it pretty good.

They show they are pretty equal and they can both do this like in *Gravity*, there was a male and female astronaut, not just both males or both females as if they are showing preferences. [In contrast,] I think in real life, the life it is not a 50/50 split on the field.

In other words, if there is any media preference, it is to show males and females as equal more than what exists in reality. Likewise, Case 5 (male) said, “I think mostly they do reflect stereotype and it is true because like a lot of science and math careers are mainly males today are also males in movies today.” When asked whether the STEM gender differences in the media are mostly true or mostly false, there are three males who think the media representations are some true or mostly true but all of females think the media is false or mostly false.

There are six cases who think that media representations have a strong or huge effect on the STEM careers males and females choose. Case 1 (male) said,

Yes it does have some influence it think. It might affect career decisions if people see something on TV or the internet they might change their views on things. If

they see it like a news broadcaster, or an article or a TV show that has something that has interest in them, it could have an effect. It does affect me, I will say so.

And also Case 3 (male) said,

I think [the media influence is] strong because family and media influences are they only logical explanation for females to not participate as much as men in STEM fields. It would affect equally because it makes males want to do STEM jobs. And it makes females want to go into work that involves being more social. Representation would be the only thing that would be a logical way that I would think of for the reasoning behind the different career choices of males and females, that females do not precipitate as much as men in STEM. It would affect both equally because, in a way, it makes the boys see like, 'Oh I want to be an engineer.' . . . I think there are significantly less [sic] teachers . . . that are males. I think they see, 'Oh the teacher that is in this movie is a girl' when they're little. And also, a lot of people think about male nurses like, 'Oh that is kind of weird.' That's just because the stereotypical nurse is a female. Same thing for girls because the engineers are boys and building things are boys.

Case 4 (female) said,

I think it has a strong effect. The media always affects people, but it seem like growing up girls see things on TV and radio: that kind of job is for man and put their head in easier things. They probably are going to be discouraged because of the lack of female representation in the media. I think it affects them when they are children more. [However,] when they get older, I think the family is a stronger effect than media and peers, because we spend so much time with our families

and they have so more influence in what we do. As we grow up, we are getting to choose a career and we need guides, and often times the parents or the people you grow up with and go to [are the ones who provide guidance].

Case 9 (female) said,

I feel like the media has a huge effect on people especially like younger people when you're vulnerable and you don't know what you want to go into and you're watching shows that make you feel like you can't really do something when you can. Sometimes the media can make the career feel like a luxury, or easy or not anything to work for and get handed it. I feel like a lot of them tend to make it look harder than what it really is.

Case 11 (female) said,

Women tend more to go to education careers and business careers than another career, so I feel like it does have an effect. I wouldn't say a strong or weak effect, but more like I mean medium effect. I don't think every woman because of media says there is only so much they can do.

And Case 12 (female) said, "I think it can affect because people see a lot of media and after seeing it so much, they kind of think that is how it is"

The other six cases think that media representations have a weak and small effect on the STEM careers males and females choose, like Case 2 (male):

No, I don't think the media really affects people. I mean you're not going to watch a movie and say, 'I want to be that.' . . . [While] I think it could affect the career decision, if you know what you want to go into, it doesn't affect much.

Also Case 5 (male) said,

I think a little bit, yes, I think they can they reflect the stereotypes you see in real life and they pass those on into the next generation to the people and think the people in the next generation are influence by the media and are encouraged to be think about certain stereotypes and certain different careers that are assigned for males and females. I think they reflect the stereotypes of the certain time when they play. Like a movie: they are watched by the next generation or usually influence the next generation.

Case 6 (female) said,

I don't think they have that much of a say in it. I don't think media affects peoples' decisions because the media over-exaggerates things or over-does things. I don't think the media might affect career decisions. I don't think it has a big impact on people. I know there are girls who see the actress and the famous people on TV and think I want to be like them, but that is how a lot of actor and actresses get their inspirations already, so they're going to pursue that as a career, and other people will look at that and say, 'I don't want that, that is too much stress.' It affects people just based off their personality and affects everyone differently.

Additionally, Case 7 (male) said, "I don't think the media has a strong affect. I think if they have agenda to promote something and they constantly hammer over and over again that may affect the decision that."

Case 8 (male) said the effect of media is "probably pretty weak. It didn't affect my decision honestly I don't think it affects people's decisions much." Likewise, Case 10 (female) said, "I think it is weak, because at this point we are trying to encourage people



to do what they want and I think that the more and more we encourage this, the more the media has an opinion that becomes obsolete.”

Four out of six of the male cases think that media representations have no effect or only a weak effect on the STEM careers males and females choose. However, most of the females (five out of six) think that media representations have a strong or huge effect on the STEM careers males and females choose. Only one of the females said it only has a weak effect.

### **Career Interests**

Seven cases believed more males choose mathematically and scientifically demanding careers than females because of the following: general stereotypes, general roles, culture, socially, and community views. For example, Case 3 (male) said,

I think people follow the general stereotypes. Engineering usually is seen as hands-on work and it seems like a male job. In the past, more females would go towards social work that involves more working with people. I think that engineering and working with your hands and building so it seems more like of a guy’s job. I think that the students are shaped by the society stereotypes, they just follow what society expects them to do.

Case 4 (female) said,

I think in this culture, at least socially, it shows more expectations for man to be those who are in the science and math and the women, historically I guess, have not been in those position and there is kind like less believe on them its less expected for women. I don’t think actually matter show intelligent you are or even good at, it is really social and cultural things.

Case 5 (male) said, “Males are more like destructive and more being able to work with STEM and females are more nurturing and being able to work fashion work and fields of nursing and childhood education.” At another point in the interview, Case 5 repeated the belief that in the nurturing quality of females and its effect on career choices:

I think that females are more nurturing than males, which leads them into more education and teaching jobs, what influences them is working with others or trying out different things, if females went into an engineering class for a couple of weeks more, they might like it more. It might increase the knowledge of women in engineering.

Case 6 (female) explained,

I think men tend to choose engineering things it seems to be more of a manly thing to do. They get to build buildings and build cars do that sort of thing, and it is just general considered a man’s job. There are more women getting into it now, but it still generally considered a man’s field. I think it is a community view they have women that have the ability, too, but they don’t have much interest in it. Some do, don’t get me wrong, there are plenty of women who decide to be engineers, but it has always been slightly discouraged, up until recently, that women shouldn’t go into that sort of field, and it is slowly wearing off. It is still considered to be a man’s domain field, but it is slowly catching up with the time.

Case 7 (male) cautiously noted,

I couldn’t say with any knowledge behind it. My best guess is maybe kind of gender roles had been set in the past. Although I will say that I do see a where women are more entering engineering types of fields or computers, so I can see

such in that [trend]. I will say that just a gender roles are stuck in the past, like 60 years or so. I think in the future that more women are going to be in engineering and the science field. There is just more opportunity and no one now will judge someone.

Case 8 (male) said, “People go towards more to their friends: guy friends are in engineering and whatever and girls go to cosmology and you know other stuff like that in high school and they select different electives and pushing towards different career.”

Case 12 (female) said, “It might be a society thing because people see more men going into those kinds of careers.”

There are two cases who thought more males choose mathematically and scientifically demanding careers than females because of their interest and more than anything else. Case (female) said,

It is based off of interest because guys use technology and are dealing with it, and when girls go into science and math majors they want to be nurses and that kind of stuff appeals to them. I think it is because of the interest that the girls don’t go into engineering.

Similarly, Case 10 (female) said, “I think it’s mainly areas of interest.”

Two cases thought more males choose mathematically and scientifically demanding careers than females because of both their interest and their family affecting their choices in their career. Case 1 (male) said,

Most of my friends that are major in engineering college they definitely have more of an interest in that field. I am not sure why most of them are males. I feel like they just enjoy it, especially with the engineering, the creative experience and

that's just what I found. I am not sure why the majority are male. I feel even though males or females have the same ability in science, I feel like it's more typical for the female to be towards the medical side. It could be due to parent's influence, and what the students enjoy doing in their free time. A lot of my male friends enjoy building things in their free time so that they're more engineering base like.

Case 2 (male) said,

I just feel like the males find, well I know that I find engineering [interesting]. I started like engineering at a young age where girls don't like that stuff at a young age. I don't think they care about it at a young age. . . . I just don't think they find it interesting much. The same ability they have . . . I think in career it would be naturally split. I don't think that there is any appeal for guys to go into engineering just they like it so they choose it.

The final case stated males go into demanding STEM jobs because they think more money and in addition to interests. Case 11 (female) said,

I think men start to do the science-based careers, like an engineering-based job, just because I know they want money and make more money than women do in that career. And I think that women choose more like healthcare- and education-based fields because it's like that motherly.

So most of the cases seem to think that there are clear differences in the interests of the genders that influence their job choices, in addition to the financial appeal drawing in more males.

## **Changes Needed**

The cases thought about what changes need to be made to increase the numbers of females working in high-level STEM careers and suggested the following solutions: make them more interested, teach children that there is no defined male or female gender for anything, stress to females that they are equal in math and science, make STEM more appealing to the younger generations, show how math and science is good for them, make them more confident, encourage them, and make sure women get paid the same as men for the same job. When we look at their answers, all cases talked about encouragement and gave some examples how to encourage.

There are six cases who said encouraging female to work in high-level STEM career. Case 5 (male) said,

I think they would have to like encourage them, starting in the middle school level. Start encouraging females to take the more science classes or engineering or more applied STEM fields. They could have them required class for everyone to take that way it is more encourage to take like for me to bring in a female role model or famous scientist that would encourage females that are like younger to peruse the STEM fields. In high school, they have the same number of boys and girls are equal in high school, but in college it is where it starts to be different.

Case 6 (female) said,

I think there needs to be something done. I think they should be shown the opportunities. Don't make it seem as much as a man's job. Show more women that do it because as soon as some people see that women can do, it they will gain confidence and then they will think, 'oh I can go and do this, it is not so much of a

man's job; it's more of an anyone's job.' How we can encourage women to do it is: we can find women who are currently in the field, because there are women working in the field, and get women who are currently in the field to talk about it and say what they like about it and all the different advantages or disadvantages that come with the field and show that it doesn't have to necessarily be entirely a man's job.

Case 7 (male) said,

I think they just need more opportunities and more encouragement—kind of an awareness campaign for women that can enjoy this field and to show some role model of women who have been in that field and what they do for society. Here in school, we are opening STEM courses for next year. So I think that can attract a lot of people of both gender because it is brand new it is not be a typically like our business program or typically guys do that or only girls can do that it is also a new program and so I think man and women going to have the same opportunities get in to it and can't be gender specific.

Case 8 (male) said,

I think that if you wanted to get more girls, you would have to just get the first group of girls to go the rest will fall out, and the initial group getting into the STEM, if we can get into then more will follow because they will see it is socially expected. I guess I would, get girls that like STEM and put them in engineering electives so that maybe encourage them to go into it and then the next couple of years you can see an increase in it and the girls follow their friends.

Case 11 (female) claimed pay differences between genders need to be corrected. She claimed,

I think like getting paid better or the same as man is a big thing, like women deserve the same amount of pay and men do. If women were paid the same, that will be a good start and then like a lot of including more girl in engineering classes and stuff like this. I think it will be good to have more women because I know like our engineering classes have three girls in two classes.

Case 12 (female) said, "I think giving examples of women in that field could help encourage other girls to go into that field of what they want to."

Case 1 and Case 2 said we should both males and females more interested. Case 1 (male) said, "I am not sure there is a way to increase it, I feel like there is a more interest in the skills. Not that they lack skill but males they find that building aspect more interesting." Case 2 (male) said,

I think in career it would be naturally split. I don't think that there is any appeal for guys to go into engineering; it's just they like it, so they choose it. I don't know how to increase it: open it up to females at a younger age? Maybe. I mean, even in the freshman classes here, there is maybe one or two or three girls per class; they just don't sign up for it. I think there is some other reason. It is not just because they are not interested.

Case 3 (male) said, "I think if you stress to females that they are equal in math, science, and engineering it will increase the numbers of females." Case 4 (female) said,

I think we need to show girls that there completely capable I just think they are discourage by the confidence males have. I think it just need some more clear

examples that girls have the same ability. I don't think they know that they have less confidence and are less certain in their selves. They are completely capable and I think we should have more programs for girls.

Case 9 (female) said,

I feel like we need to make STEM more appealing to the younger generations because I feel like their experiences in high school really reflect their experiences they have in college. So I feel like if they don't have that good experience in STEM in high school. They are not going to want to peruse it in college and that kind of stuff.

Case 10 (female) said,

It's just society's conception and the idea that females are told that this is a women job and this is a man's job and stay separate. That is something that is left over from when that belief was still held that women were inferior to men. I think that we are working hard to get rid of that right now. People who were raised with that thought are like, 'I can't do this because I am a girl.' You know they tend to think that even if it's true or not. [We need to] teach children that there is no defined male or female or no gender for anything. If a woman wants to be mathematics and has an interest in science then let her do science, who's to stop her if they had the same mental capabilities? Why wouldn't they be able to do it? I think it starts early not tell these little kids you know preschoolers no that is a man's job no that's a thing boys do and girls do. For example if a boy wants to play with a doll go let him.



The majority of the cases emphasized the importance of starting early with positive examples.

### **Perceived Gender Differences**

Most of the cases said that in their experience, males in STEM classes are more confident, less stressed, more naturally skilled, have higher comprehension, and are more interested than females, while they believed females are less confident, less certain of their selves, more worried, afraid to be wrong, and quieter but study more and put in more effort than males. Female cases believed females in general think more abstractly, are more organized, are more self-driven, are more motivated, and have a more mature mind than boys.

## Chapter Seven

### Discussion

The lived experiences of the cases based on the interviews can be divided into individual and social factors. The individual factors include preferences, interests, performance, and ability. The social affects can be divided into family, peers, teachers, and media stereotypes. From these findings, a few important themes emerged: Intended Choices Follow Family Influences, the Myth of Gender Differences Persists in Subtle Ways, Teenagers Have A Limited Future View, and the Chicken and the Egg: Interest First or Social Influence. Together, these themes form the essence of the lived experience of being a STEM student today.

#### **Individual Factors**

From the interviews, all the males and females reported enjoying science; however, while all males reported enjoying math, just three of the females reported enjoying math. In Pilot Study I, no major differences in attitude and preferences in STEM were found among the 11<sup>th</sup> and 12<sup>th</sup> grade male and female students. There were some differences in the pilot, but they were gender differences in activities and intended career choice. In Pilot I, there were no differences in the preferences for the subject itself.

#### **Performance**

The cases in this dissertation reported that they believe performance in STEM is pretty equal between male and female students. From the interviews, there are five cases who reported that male and female are the same in their performance in math class, four who believe females are better, and three who believe males are better. Likewise, the results from Pilot Study II found that the cases believe males and females have the same

ability. These findings about performance from the dissertation and the pilots align with the literature. Ding (2006) found there were no significant differences in the growth rate in math performance for both males and females.

### **Self-Concept**

Even when some performance differences are noted in the literature, such as in high-stakes test scores, Hannon (2012) argued that the test anxiety and performance avoidance goals accounted for all of the gender differences in performance as a result of social/learning factors. Two influential social/personality factors are that females experience more test anxiety and have higher performance-avoidance goals (Hannon, 2012). Also, it is widely reported that male students have higher self-concept, performance expectations, and self-enhancing ego orientation in mathematics than female students (Skaalvik & Skaalvik, 2004).

The findings from the interviews in this dissertation also show that the cases believed male students think more highly of themselves and their ability. Likewise, Rudasill et al. (2009) observed that gifted students' score in several self-concept domains were lower for older adolescents and girls, but remained relatively high across grade and gender for scholastic self-concept. Crombie et al. (2005) found that girls' competence beliefs in math had a central role for predicting not only current math grades, but also future math enrollment intentions.

### **Motivation**

However, they think the females work harder, are more focused on grades, and are more organized. The cases reported that females care more about grades in STEM than male students. This finding is similar to the literature. Skaalvik and Skaalvik (2004)

reported that females were more extrinsically motivated in STEM, which means grades and social recognition, while males students are more intrinsically motivated, such as by their inquisitive and curiosity about the subject. Some of the literature also reported female students are more concerned about the appearance of ineptitude in science class, which correlated with their grades (Britner, 2007).

### **Participation**

In addition to believing females are more motivated by grades, focused, and organized, the cases also reported that females participate more in their experience. From the interview, there were four cases who thought females participate more than males in math, six who thought they participate the same, and only two who reported males participate more. For science, the five cases reported they are the same, four reported females participate more, and three reported males. A more recent claim from Van de gaer et al. (2008) asserted boys attach a higher value and utility to math for career choices and have higher self-concepts in math, which may explain why they choose to participate more in math than girls. However, the literature reveals different findings. Some evidence suggests females are less likely than males to participate in science activities outside the classes (Amelink, 2009). Additionally, Van de gaer et al. (2008) found that the differences shifted over time: at the beginning of school in math achievement boys scored significantly higher than girls, but the gap closes and girls even surpass boys at higher grade levels.

### **Interests**

The cases were inconsistent in their experiences with the influence of personal interests. The majority of the cases reported that their interests affect why they make the

academic choices they have made, as well as why they have certain intended career choices; however, when asked about social influence, they tended to report that social factors influence their personal interests. The male interviewees in particular seemed to think that females choose their majors and careers based more on interests and innate abilities than salary. Rudasill et al. (2009) explained that the complexity of the relationship between personal interests and social influence centers on the dynamic formation of self-concept. Rudasill et al. found that self-concept influences the development of interests and interests shape self-concept along with input from social factors. For instance, Santrock (2008) noted that peers extensively reward and punish gender-related behavior, creating a set of gender-appropriate/-inappropriate behaviors and interests. In other words, the interests of the individual may be discouraged or reinforced by social influence. The importance of understanding the effect of interests is highly supported in the literature. Haussler and Hoffmann (2002) found an intervention that adapted the curriculum to the interests of girls and which promoted the ability of girls resulted in improved immediate and long-term achievements for both boys and girls. As Kralina (2010) notes, perception is reality when it comes to choices made and interests held, finding that the previously held beliefs students had about a science program influenced their interests.

### **Social Factors**

Generally, the cases think social environment and stereotypes do affect the choices and interests for majors and careers. Benbow and Stanley (1980) argued that there are no differences in males and females in their ability, but there are differences in support and encouragement from their teachers, peers, and parents. Gender roles can

develop and get reinforced by media, peers, family, and classroom factors (e.g., teacher, textbook, and lesson plans). As a result, the focus of socialization theorists is to change these factors so that they are more open and gender neutral. The broad banner under which these efforts fit is “equal opportunities” for both boys and girls (Acker, 1987). Based on the interview responses, the cases believe media has the least influence, teachers have very little influence, peers have some influence, and parents/family have the most influence.

### **Media**

The cases said media stereotypes and representations are unrealistic characters, but they do not have much influence on their choices and preferences. However, the research shows that stereotypes do influence beliefs and choices. Bauman (2012) found gender stereotypes and role modeling may be more influential for adolescent males than for females. It is perhaps the case that the cases are not very aware of how the media influences their perspectives and interests.

### **Teachers**

Also, teachers do not make much difference—generally the same/similar. This is in contrast to the literature. In the literature, Amelink (2009) argued that “Teacher attitudes and behaviors may vary depending on the gender of the student, possibly creating classroom climates that are biased towards males” (p.16). Amelink further claimed negative attitudes about science related disciplines that are driven by gender-biased stereotypes may influence the number of women who pursue degrees in the STEM field. According to Dee (2006), both boys and girls benefit by having male and female teachers as role models, stating, “the gender interactions between teachers and students

have statistically significant effects on a diverse set of educational outcomes: test scores, teacher perceptions of student performance” (p. 222). Interestingly, Dee found that having a female teacher instead of a male teacher raised the achievement of girls and lowered that of boys in science. In another study, female adolescents reported receiving statistically significantly more educational encouragement from teachers than did male adolescents (Khan, 2012).

### **Peers**

Peers have some influence according to the cases. The research has shown noticeable gender differences in peer influence. Ormrod (2007) observed that boys and girls interact with peers in distinctly different ways. Santrock (2008) also noted that peers extensively reward and punish gender-related behavior, creating a set of gender-appropriate/-inappropriate behaviors and interests. Khan (2012) found that female adolescents reported receiving statistically significantly more educational encouragement from their friends than did male adolescents.

### **Parents and Family**

Parents and family have a lot of influence on the academic and career interests and choices of individuals according to the cases. Likewise, Meece et al. (1992) noted that parental beliefs about their children’s abilities have a strong influence on their children’s own beliefs about their academic abilities. Santrock (2008) found that parents have higher expectations for boys' STEM skills. Similarly, Wang, Oliver, and Staver (2008) reported that parents held higher perceptions of mathematical abilities and higher expectations of success in STEM education and related careers for males than for females. Wang et al. (2008) reported parents’ expectations for STEM education and

STEM careers affect future career aspirations among females. The effect of parental expectations and the persistent gender bias in the household could be a contributing factor in the continual disparity in STEM career choices by gender.

### **Addressing the Problem According to the Cases and Literature**

To address the career gap, cases recommended increased encouragement to address confidence issues. As Van de gaer et al. (2008) found, boys attach a higher value and utility to math for career choices and have higher self-concept in math explain why they choose to participate more in math than girls. A similar claim from Van de gaer, Pustlens, Van Damme, and De Munter (2008) asserted boys attach a higher value and utility to math for career choices and have higher self-concepts in math, which may explain why they choose to participate more in math than girls. Alternatively, Wang, Oliver, and Staver (2008) claimed that given the influence of parents' expectations for STEM education and STEM careers on future career aspirations of females, educators could inform and promote female students towards career opportunities and role models in STEM fields, as well as the academic preparation needed to succeed in these fields. They can also work harder to incorporate the family in educational efforts that have reformed gender expectations following the gender socialization theory.

### **Encouragement, Praise, and Confidence**

The biggest suggestion the cases provided to close the career gap in STEM was encouragement. One way to encourage students is through actual role models. Role models, or lack thereof, can influence both young males and females, but perhaps males are more susceptible. Bauman (2012) found gender stereotypes and role modeling may be more influential for adolescent males than for females. Amelink (2009) speculated that



negative attitudes about science related disciplines that are driven by gender-biased stereotypes that science is a male-dominated field may influence the number of women who pursue degrees in STEM field. However, the cases reported media and stereotypes were not very influential, so perhaps it is not necessary to focus on that social ecological level. Role models can be in the form of parents, teachers, and local successful people who can visit classrooms, lead field trips, or organize educational extracurricular activities that promote STEM among girls or both genders equally.

Bussey and Bandura (1999) argue that the differential precollege preparation stems from differences in support and encouragement from teachers, peers, and parents to pursue quantitative and scientific coursework, not from differences in ability. AWE (2009) suggested the classroom climates factor might facilitate male learning in science, stereotypes, community support, and assessments used might have gender bias. Benbow and Stanley (1980) argued that there are no differences in males and females in their ability, but there are differences in support and encouragement from their teachers, peers, and parents. Khan (2012) found evidence that female adolescents reported receiving statistically significantly more educational encouragement from family and teachers

The importance of encourage all students, especially females, to participate more in STEM becomes more important as students get older. Benbow and Stanley (1980) cited that as students move into high school, girls lose their confidence in their ability in math. Similarly, Bussey and Bandura (1999) cited that the gap in the perceived ability and self-efficacy grows as boys and girls age, with girls beginning to lose confidence in their math abilities relative to boys as they move into high school. These findings agree with what Case 5 (male) observed, “I think people, especially in high school, follow their

friends and what their belief is [...].” Based on the literature and the interview findings, high-school-aged students should be a target population for increased encouragement.

Haussler and Hoffmann (2002) found an intervention that adapted the curriculum to the interests of girls and which promoted the ability of girls resulted in improved immediate and long-term achievements for both boys and girls among German students. Cunningham (2007) found extracurricular and informal learning experiences, including participation in science competitions or science-related field trips, promotes females’ science achievement and interest in engineering. Teacher training could involve teacher training that includes strategies to promote both genders in science and counteract persistent stereotypes and misconceptions as well as how to provide lessons appealing to both genders (AAUW, 2011).

In classrooms where teachers emphasize the usefulness of quantitative skills, encourage cooperative rather than competitive learning, and minimize social comparisons of ability, both females and males perform well (Eccles, 2005). Cunningham (2007) found that extracurricular and informal learning experiences, including participation in science competitions or science-related field trips, promote females’ science achievement and interest in engineering.

### **Equal Opportunities**

A second recommendation was more opportunities. An unexpected finding was that none of the cases discussed the issue of motherhood and the expectation that mothers to take care of families more than fathers, which affects time/money in a demanding field. The literature emphasizes the influence of this point. Perhaps they are too young/inexperienced to think about the effect of parenthood on career choices.

Surprisingly, only one student mentioned the influence of money/salary (Case 11, Female).

### **Biggest Themes**

Based on the synthesis of findings from the previous literature and the interview results from the cases in this dissertation, a few major themes emerged. The four major themes were: Intended Choices Follow Family Influence, Myth Persists in Subtle Ways, Teenagers Have a Limited Future View, and The Chicken and the Egg: Interest First or Social Influence? Essentially, the experiences of the cases are best described by these themes.

#### **Intended Choices Follow Family Influence**

According to the lived experiences of the cases, families and particularly parents have a strong influence on academic and career choices of their children. However, it is not clear how true this lived experience is because most of the cases cited indirect stories about friends or other cultures following parents' wishes. Very few of the cases admitted experiencing their own parents influenced their decisions. Still, two cases mentioned the direct influence of their family/parents on preferences and choices.

In Feminist Socialization Theory, the main aim of liberal feminist education is to secure equal opportunities for both sexes (Acker, 1987). Socialization theorists argue that by treating girls as rational and capable individuals, girls will prove themselves just as smart, independent, confident, and creative as boys (Thompson, 2003). It seems one of the remaining unaddressed territories in feminist socialization reform is the home, where the family has a strong influence. Santrock (2008) discovered that interactions between the child and social environment are the main keys to gender development and the

differences that emerge based on gender, especially family differences and parental influence.

According to the feminist phenomenological perspective, gender performances are more rigid in the home because the expectations are clearer and more enforced. Outside of the home, whether in school or in the streets. Online provides the most gender fluidity because it is divorced from the body and has a greater level of anonymity. The home seems to be the most conservative space for gender expectations and therefore should be the stage of future reforms in gender roles and differences in STEM.

### **Myth Persists in Subtle Ways**

The cases reported that media and stereotypes do not influence them in their lived experiences. However, it can easily be argued that the cases simply are unaware of how these factors influence them because they are more indirect and implicit than the immediate influence of family. For instance, Nosek, Smyth, Syriram, Lindner, Devos, et al. (2009) stated that experimental research has demonstrated causal effects of implicit stereotypes on inequalities and suggested that the mere observation of inequalities can influence stereotypes and choices.

One of the subtle ways in which gender discrimination persists is in jokes. Case 3 (male) said even if they joke or exaggerate the myth, they believe in it in some way. “When people make jokes, they believe it a little bit.” These seemingly innocent jokes can influence male dominant social expectations and stereotypes in science and math ability and therefore contribute to the persistent gender gap in participation and performance. Santrock (2008) defined gender roles as the “social expectation that prescribe how males and females should think, act, and feel” (p. 165). Gender stereotypes

are broad categories that reflect impressions and beliefs about what behavior is appropriate for females and males (p.167). McLaren and Gaskell (1995) argued that by reading the culture and interviewing girls' experience in science class, it suggests that science is a male domain, and boys can more easily reproduce its messages than girls. Amelink (2009) claimed negative attitudes about science related disciplines that are driven by gender-biased stereotypes may influence the number of women who pursue degrees in STEM field. As a result of these subtle ways in which the myth of gender differences persist, the future intentions of female students in pursuit of STEM careers may be discouraged by female gender stereotypes in STEM fields.

One very important way the myth of gender differences persists is in the wage gap. Case 11 (female) claimed males pursue STEM fields “because I know they want money and make more money than women.” She also said, “Women deserve the same amount of pay as men do. If women were paid the same that will be a good start.” It is often cited that women make an average of \$0.70 per every \$1.00 a man is paid. The argument is that this pay discrepancy occurs because of unfair pay practices for the same work. However, many studies have demonstrated that this wage difference disappears when one looks at the specific field and compares the same exact jobs (e.g., technician with technician; manager with manager). The pay difference persists because women tend to go into the lower paying jobs, which are not in the STEM field and are not in leadership.

It is necessary to critique these subtly persistent myths of gender differences in STEM fields as constructions rather than fact. Doing so can shift the lived experience away from passively receiving and reifying the myths and towards critiques and acts that

subvert the myth. This can help empower male and female students to actively resist the dominant image in their lived experience. As Butler (1988) pleads, “if this continuous act is mistaken for a natural or linguistic given, power is relinquished to expand the cultural field bodily through subversive performances of various kinds” (p. 531). Without acknowledging how the gender myths and differences are constructed, then the potential for change is forfeited. Because the cases did not clearly acknowledge how the myth and the media representations affect their belief, they were not in a good position to question or challenge them as social constructions.

### **Teenagers Have a Limited Future View**

The cases only discussed their current situation and perhaps one step ahead: college. Not even one student talked about the future beyond their possible major and a vague career idea. They did not mention the future responsibilities of parenthood and gender differences in mother/father expectations or responsibility alongside school and career. This limited future view suggests that future aspirations are not a major motivating factor in current choices. In other words, these students did not seem particularly driven to pursue a specific major or career. When they did discuss careers, they did not mention specific career choices and spoke very generally about them.

### **The Chicken and the Egg: Interest First or Social Influence?**

One concept that emerged from the interviews is the blurred line between personal interests and social influence. In this chicken–egg situation, the cases were uncertain about whether social pressures or their interests came first. The cases changed their minds about this depending on the topic. First interest was perceived as most

important. Then when they discussed more, they started to say interests came from social influence (family especially) around them.

In feminist phenomenology, the individual experiences gender as a social influence first, but the individual can challenge social influence to a point. As Butler (1988) has argued, the dominant script precedes individual awareness of the script and it exists above any one individual. In Butler's words, "The act that one does, the act that one performs, is, in a sense, an act that has been going on before one arrived on the scene" (p. 526).

The script, i.e. social influence, is broad and collective, with each individual contributing to it by adding, erasing, and revising parts of the script through actions and performances. Individual subversion of the dominant script, though, tends to almost immediately get folded back into the dominant social influence. Butler argues

Because there is neither an 'essence' that gender expresses or externalizes nor an objective ideal to which gender aspires; because gender is not a fact, the various acts of gender creates [sic] the idea of gender, and without those acts, there would be no gender at all. Gender is, thus, a construction that regularly conceals its genesis. (Butler, 1988, p. 522)

Because these dynamic series of stylized acts and broader performances write the script as the lived experience is being experienced, the gender "regularly conceals its genesis," hence why the students struggled to identify whether personal interests or social influence were stronger factors in their choices.

The most significant finding in this study is that even after decades of instructional trends that have striven to balance the expectations and opportunities of both

male and female students in math and science, some myths about gender differences still persist. The educational system has made great strides in closing the gender gap in STEM achievement since the early '80s, and in many places around the world, the gap is starting to close as well; however, with persistent disparities in media representation and with the highest levels of STEM education and career opportunities still male dominated, there are still persistent beliefs that males can achieve more in math and science. The lived experiences of the students in this study showed that they felt the representation of women in key and visible STEM positions is still either non-existent or full of stereotypes. That means more work is needed to continually address this disparity to minimize the belief in gender differences, maximize the opportunities available, and accommodate women even in the highest and most demanding STEM fields.

### **Recommendations**

More interviews should be conducted to determine how students explain beliefs and myths about the phenomenon of more males in highly mathematical careers in the STEM field, and how students perceive that phenomenon.

Another recommendation is that high schools need to prepare students for future realities, such as college, career, and family. In many countries around the world, such as Germany and Saudi Arabia, students are expected to choose their general education track in high school, which leads to career choices. That means 15 year olds choose whether they prefer a college-bound STEM track or a humanities track, or alternatively a trade/vocational/business school. This gets them thinking about their interests and desired careers early. Also, it allows them to begin pursuing their career before life and family demands become too influential. Similarly, life skills such as family management and



personal finance and budgeting need to be promoted early to get students thinking about the realities they will face in the future. Emphasis on these realities will encourage students to make realistic choices based on a combination of interests and social realities.

Similarly, the discussion of unequal pay based on gender needs to move beyond the myth that women are discriminated against and towards a focus on how major, career, and lifestyle choices affect pay. If one wants more pay, one will have to sacrifice more time, study more, and work more hours in demanding jobs. Along with emphasizing career and major choices early on, emphasizing how choices will affect future pay scales may encourage more female students to pursue STEM fields.

Families have a very strong influence on their children and at the same time are slower to change from generation to generation. As the saying goes, “the apple doesn’t fall far from the tree.” Based on the results of the study in this dissertation, the cases largely reported being heavily influenced by parents. For example, Case 2 told a story about how he became interested in engineering because his father played with him as a child and they worked together to build things. Likewise, Case 3 emphasized that parents heavily influence what they want their children to study because often they pay for their education either partially or completely. Parents also expect children to follow in their footsteps and sometimes even take over the family business or trade (Case 3).

While every individual has a choice, with certain choices come consequences. While many social barriers have been removed to help females succeed more in STEM, there are still some less obvious consequences that still discourage female participation at the highest levels. One area of focus based on the results of this dissertation needs to be on the influence of tradition, expectations, and modeling that a family provides. As noted

in the literature, children are always learning from observing, and learning extends beyond the classroom into all of life. The family has the most direct, persistent, and dominant influence on the choices and individual makes. More attention needs to be placed on how educators can work with families to make more changes in the perceived choices males and females have in STEM.

Some possible ways to move forward is to extend education beyond the classroom into the community and with the family. The more parents can be involved in their children's' education, the better. Math and science extracurricular activities after school, on the weekends, and during summers can involve different family members together to reinforce the values of these subjects for both boys and girls. Based on the results of the interviews, these kinds of family experiences have a strong influence on what the child prefers and chooses to do in his or her own life

### **Limitations**

One limitation to this study is the small sample, which included 12 students from one school who are not representative of a large population. This would be especially problematic for generalizing quantitative results to make conclusions about a broad population. However, the methodology was qualitative and not quantitative, so the conclusions really lead to asking better questions and creating some hypotheses rather than generalizing the findings. Ultimately, these lived experiences only apply to these students. However, they at least give some idea of what some 12<sup>th</sup> grade students think about gender differences, interests, social influence, and their future in the STEM fields.

High school students have a vague understanding of their environment and future, so they are not very insightful about what actually affects their interests and choices. In

fact, social, economic, family, and regional factors have a large influence on choices and availability of opportunities, so they are often out of the individual's control or even awareness. Therefore, interviewing high school students on these questions can only generate limited responses. This limited worldview was accounted for in the discussion.

### **Conclusion/Summary**

As the literature review showed, there was a large disparity between men and women in terms of achievement and participation in STEM. Throughout history and up until the 1970s and '80s, males vastly outnumbered females in STEM courses, majors, and careers. Moreover, in this climate of gender discrimination, females actually performed worse in these subjects as well, achieving lower grades and test scores. Likewise, in parts of the world today, this gender discrepancy is still the case. One of the most famous recent cases in the news is Malala, the young girl from Pakistan who was shot by supporters of the Pakistani Taliban simply for trying to go to school as a girl. Although an extreme case, a wide range of gender discrimination exists in various parts of the world, allow female students more or less access to education and particularly STEM education.

This historical and cross-cultural evidence demonstrated that most of the evidence about a gender disparity in STEM abilities and performance is the result of gender socialization. Throughout the past 40 years, however, efforts to focus on how schools contribute to this gender disparity have increased. Various feminist theories, including Gender Socialization Theory, were used to critique how teachers and curricula affected female students and reinforced gender stereotypes in STEM. For example, historically, textbooks used to feature males in photographs of doctors, scientists, and mathematicians,

reinforcing the idea that these jobs and subject areas are for men. As these stereotypes and biases were actively critiqued and dismantled in the educational system throughout the '70s, '80s, and '90s, scores and grades for girls in STEM steadily increased and in some cases even surpassed those of boys. The basic claim of Gender Socialization Theory that has driven these changes is that, if boys and girls are treated as individuals capable of the same achievements in STEM, the participation and success of females in these fields will increase.

Even though schools have changed throughout the years to accommodate and encourage female students in STEM, there is still a persistent disparity in participation at the highest levels of STEM in education and in careers. Males still outnumber females in the more mathematical and technical sciences, such as computer science and engineering. There are clearly more factors that contribute to this gender socialization, which may be a combination of socioeconomic status and the influence of family.

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## Appendix A

### Informed Consent for Parents

IRB # 107826



Department of Curriculum & Instruction  
Department Address: Gillham Hall 2000 LL  
Toledo, Ohio 43606

Phone #419-530-5373

### **ADULT RESEARCH SUBJECT - INFORMED CONSENT FORM**

*Gender differences in humanitarian versus systematic science learning preferences*

**Principal Investigator:**

Amamah Alkhadrawi

Ph.D. students at University of Toledo

4193781406

**Purpose:** You are invited to participate in the research project entitled, “*Gender preferences in selecting math and science course and career*” which is being conducted at the University of Toledo under the direction of principal investigator Amamah Alkhadrawi under the advisor Dr. Leigh Chiarelott. The purpose of this study is this study may help lead to an improved understanding of why such a difference between genders exists in course enrollment numbers. It is important that you answer honestly and as accurately as possible. Doing so will help the education field better understand the phenomenon of gender differences in science courses boys and girls prefer. There are two major concept related to this research: the first major concept is the term “human application of science” which describes scientific fields such as biology, life sciences, and psychology that emphasize human beings and more broadly living things. It is perhaps understood better in contrast to the second major concept: “scientific systems.” As opposed to human application, scientific systems do not focus on living things but rather systems of objects (often inanimate). It especially includes fields such as engineering, computer science, and physical science.

**Description of Procedures:** This research study will take place in only focuses on 12<sup>th</sup> grade students in science class at high schools in Northwest Ohio and South East

Michigan. The *interview will take 20-30 minutes. The 12 students (6 boys and 6 girls) for interview will be chosen randomly.* The researcher will visit the schools two times: first to distribute the consent forms for students to take home to their parents and the second time to collect the signed consent forms and administer the interview. The teacher must sign the consent form before his/her students can participate in the survey. Any classes without a teacher's signed consent will be excluded. Surveys will be distributed to 8<sup>th</sup> grade students. Identifying data will only be used for reference and will not be published.

After completing the interview, the researcher will have a debriefing session for teachers and students about the data, theory and research area under study and answer any questions they may have about the research.

**Potential Risks:** There are minimal risks to participation in this study, including loss of confidentiality and their right to stop participation at any point. Other than this minimal risk, there are no more anticipated risks to participating in this survey than those normally encountered in everyday life. Choosing to participate or to not participate will not impact your relationship with the University of Toledo. Moreover, your responses or decision to participate in this research project will not impact your grades or relationship with your school/institution. Your decision to participate or not in this survey is entirely at your discretion. You are free to withdraw from the study at any time. There is no penalty for not completing the survey. However, any information you provide will be helpful and greatly appreciated.

**Potential Benefits:** The only direct benefit to you if you participate in this research may be that you will learn about how education experiments are run and may learn more about gender differences. Others may benefit by learning about the results of this research. It will assess whether the gender difference is influenced by whether the science course focuses on humanitarian versus systematic application of science.

**Confidentiality:** The researchers will make every effort to prevent anyone who is not on the research team from knowing that you provided this information, or what that information is. The consent forms with signatures will be kept separate from responses, which will not include names and which will be presented to others only when combined with other responses. Although we will make every effort to protect your confidentiality, there is a low risk that this might be breached.

**Voluntary Participation:** Your refusal to participate in this study will involve no penalty or loss of benefits to which you are otherwise entitled and will not affect your relationship with The University of Toledo or any of your classes. In addition, you may discontinue participation at any time without any penalty or loss of benefits.

**Contact Information:** Before you decide to accept this invitation to take part in this study, you may ask any questions that you might have. If you have any questions at any time before, during or after your participation you should contact a member of the research team: Amamah Alkhadrawi, 419-378-1406, and Dr. Leigh Chiarelott, Professor and Chair, 419-530-5373

If you have questions beyond those answered by the research team or your rights as a research subject or research-related injuries, the Chairperson of the SBE Institutional Review Board may be contacted through the Office of Research on the main campus at (419) 530-2844.

Before you sign this form, please ask any questions on any aspect of this study that is unclear to you. You may take as much time as necessary to think it over.

**SIGNATURE SECTION – Please read carefully**

You are making a decision whether or not to let your child participate in this research study. Your signature indicates that you have read the information provided above, you have had all your questions answered, and you have decided to take part in this research.

The date you sign this document to enroll in this study, that is, today's date must fall between the dates indicated at the bottom of the page.

Name of Subject (please print)	Signature	Date
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Name of Person Obtaining Consent	Signature	Date
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This Adult Research Informed Consent document has been reviewed and approved by the University of

Toledo Social, Behavioral and Educational IRB for the period of time specified in the box below.

Approved Number of Subjects: **107826**

## Appendix B

### Informed Consent for Teachers

IRB # 107826



Department of Curriculum & Instruction  
Department Address: Gillham Hall 2000 LL  
Toledo, Ohio 43606

Phone #419-530-5373

### ADULT RESEARCH SUBJECT - INFORMED CONSENT FORM

*Gender differences in humanitarian versus systematic science learning preferences*

**Principal Investigator:**

Amamah Alkhadrawi

Ph.D. students at University of Toledo

4193781406

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distribute the consent forms for students to take home to their parents and the second time to collect the signed consent forms and administer the interview. The teacher must sign the consent form before his/her students can participate in the survey. Any classes without a teacher's signed consent will be excluded. Surveys will be distributed to 8<sup>th</sup> grade students. Identifying data will only be used for reference and will not be published.

After completing the interview, the researcher will have a debriefing session for teachers and students about the data, theory and research area under study and answer any questions they may have about the research.

**Potential Risks:** There are minimal risks to participation in this study, including loss of confidentiality and their right to stop participation at any point. Other than this minimal risk, there are no more anticipated risks to participating in this survey than those normally encountered in everyday life. Choosing to participate or to not participate will not impact your relationship with the University of Toledo. Moreover, your responses or decision to participate in this research project will not impact your grades or relationship with your school/institution. Your decision to participate or not in this survey is entirely at your discretion. You are free to withdraw from the study at any time. There is no penalty for not completing the survey. However, any information you provide will be helpful and greatly appreciated.

**Potential Benefits:** The only direct benefit to you if you participate in this research may be that you will learn about how education experiments are run and may learn more about gender differences. Others may benefit by learning about the results of this research. It will assess whether the gender difference is influenced by whether the science course focuses on humanitarian versus systematic application of science.

**Confidentiality:** The researchers will make every effort to prevent anyone who is not on the research team from knowing that you provided this information, or what that information is. The consent forms with signatures will be kept separate from responses, which will not include names and which will be presented to others only when combined with other responses. Although we will make every effort to protect your confidentiality, there is a low risk that this might be breached.

**Voluntary Participation:** Your refusal to participate in this study will involve no penalty or loss of benefits to which you are otherwise entitled and will not affect your relationship with The University of Toledo or any of your classes. In addition, you may discontinue participation at any time without any penalty or loss of benefits.

**Contact Information:** Before you decide to accept this invitation to take part in this study, you may ask any questions that you might have. If you have any questions at any time before, during or after your participation you should contact a member of the

research team: Amamah Alkhadrawi, 419-378-1406, and Dr. Leigh Chiarelott, Professor and Chair, 419-530-5373

If you have questions beyond those answered by the research team or your rights as a research subject or research-related injuries, the Chairperson of the SBE Institutional Review Board may be contacted through the Office of Research on the main campus at (419) 530-2844.

Before you sign this form, please ask any questions on any aspect of this study that is unclear to you. You may take as much time as necessary to think it over.

**SIGNATURE SECTION – Please read carefully**

You are making a decision whether or not to let your students participate in this research study. Your signature indicates that you have read the information provided above, you have had all your questions answered, and you have decided to take part in this research.

The date you sign this document to enroll in this study, that is, today's date must fall between the dates indicated at the bottom of the page.

Name of Subject (please print)	Signature	Date
Name of Person Obtaining Consent	Signature	Date

This Adult Research Informed Consent document has been reviewed and approved by the University of Toledo Social, Behavioral and Educational IRB for the period of time specified in the box below.

Approved Number of Subjects: 107826



## Appendix C

### Informed Assent for Students

IRB # 107826



### CHILD RESEARCH SUBJECT ASSENT FORM

*Gender differences in humanitarian versus systematic science learning preferences*

**Principal Investigator:**

Amamah Alkhadrawi ,

Ph.D. students at University of Toledo

419-378-1406

- You are being asked to be in a study to help understand people better.
- You should ask any questions you have before making up your mind. You can think about it and discuss it with your family or friends before you decide.
- It is okay to say “No” if you don’t want to be in the study. If you say “Yes” you can change your mind and then quit the study at any time without getting in trouble.

*We are doing a research study about to find out the differences between boys’ and girls’ preferences and course choices in science course and career. A research study is a way to learn more about people. If you decide that you want to be part of this study, you will be asked to complete an interview will take 20-30 minutes. The 12 students, 6 boys and 6 girls, for interview will be chosen randomly.*

*Not everyone who takes part in this study will directly benefit. A benefit means that something good happens to you. We think these benefits might be to help to improve science class for both*

*genders. When we are finished with this study we will write a report about what was learned. This report will not include your name or say that you were in the study.*

*If you have any questions about the study, you can ask Amamah Alkhadrawi, 419-378-1406. You can call the investigator listed at the top of this page if you have a question later.*

***If you decide to be in this study, please print and sign your name below.***

*I, \_\_\_\_\_, want to be in this research study.*

*(Print your name here)*

*Sign your Name: \_\_\_\_\_ Date: \_\_\_\_\_*

## Appendix D

### Pilot Survey

Age: \_\_\_\_\_

Gender: \_\_\_\_\_

School: \_\_\_\_\_

#### **Part 1: Attitude towards science and math**

1. I enjoy science.

1                      2                      3                      4                      5

Strongly Disagree / Disagree / Neither Agree nor Disagree / Agree / Strongly Agree

2. I am good at science.

1                      2                      3                      4                      5

Strongly Disagree / Disagree / Neither Agree nor Disagree / Agree / Strongly Agree

3. I am interested in pursuing a career in science.

1                      2                      3                      4                      5

Strongly Disagree / Disagree / Neither Agree nor Disagree / Agree / Strongly Agree

4. I enjoy math.

1                      2                      3                      4                      5

Strongly Disagree / Disagree / Neither Agree nor Disagree / Agree / Strongly Agree

5. I am good at math.

1                      2                      3                      4                      5

Strongly Disagree / Disagree / Neither Agree nor Disagree / Agree / Strongly Agree

6. I am interested in pursuing a career in math.

1                      2                      3                      4                      5

Strongly Disagree / Disagree / Neither Agree nor Disagree / Agree / Strongly Agree

**Part 2: Preferences of science activities and materials.**

A high school curriculum asks you to choose **ONE biology (A)** course and **ONE physics (B)** course from the options below. Choose the course based on the one that sounds the most interesting and enjoyable to you.

**A- Read both course descriptions carefully. Then, check the box for the biology class you would like to take. Only check one box for biology.**

☐ 1. Biology Course 1

☐ People use biological sciences to understand the relationship between various life forms. This biology course focuses on how biology can be used to improve our life on earth and how humans can live more harmoniously with various life forms. Key topics include the paternal behaviors of animals, symbiotic relationships, life cycles, and the effect of human activity and pollution on biomes and populations.

☐ 2. Biology Course 2

☐ Biology can be understood as a series of cycles and systems in interaction with each other. This biology course emphasizes how individual units and building blocks of life fit within internal and external systems of plants and animals. Key topics include taxonomic classifications of plants and animals; parts of the cell; circulatory, neurological, digestive, respiratory, and reproductive systems; and larger ecological cycles.

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**B- Read both course descriptions carefully. Then, check the box for the physics class you would like to take. Only check one box for physics.**

☐ 1. Physics Course 1

☐ Physical science is the study of objects, mass, energy, forces, and movement. Every object behaves according to physical laws from the atoms to planets and everything in between. Learning these physical laws and scientific systems improves our ability to understand with accuracy and precision how the systems

around us work. Key topics include mass, energy, friction, gravity, and speed and how they work with vehicles, machines, and electronics.

☐ 2. Physics Course 2

- ☐ Harnessing the power of physics has allowed humans to gather energy from natural resources, communicate across great distances, and save lives. This course focuses on how physics helps people improve life and society. Key topics include using communicating with radio, satellite, and electricity; powering cities with chemicals, mechanics, thermodynamics, and electricity; and the physical limits of the human body.

A high school curriculum asks you to choose **ONE algebra (A)** course and **ONE geometry (B)** course from the options below. Choose the course based on the one that sounds the most interesting and enjoyable to you.

**A- Read both course descriptions carefully. Then, check the box for the algebra class you would like to take. Only check one box for algebra.**

1. Algebra Course 1

People use algebra to determine the relationship between variables. This algebra course applies algebra to real-world problems, such as maximizing the use of space in architectural design, calculating how to save the most money in a budget, converting recipes depending on the number of people, and charting population growth trends. The final project will require students to work in groups to use algebra to solve a problem that has some connection to society.

2. Algebra Course 2

Algebra is the systematic analysis of quantitative problems. The logic of algebra is based on various rules, operations, axioms, and laws of numbers, which, when applied correctly, can solve a wide-range of challenging problems. In this way, algebra is like a puzzle or a game: with the right strategy, the solutions can be found efficiently. This algebra course will develop approaches, strategies, and even a few tricks to improve the students' problem solving speed and ability. The final assignment will be a tough problem that can be solved with basic algebra skills if they are applied correctly.

**B- Read both course descriptions carefully. Then, check the box for the geometry class you would like to take. Only check one box for geometry.**

1. Geometry Course 1

- ☐ Geometry is based on the rules and properties of shapes, which are composed of different numbers and sizes of angles and sides. Because of the properties of these sides and angles, a wide range of problems can be solved with only limited information. The emphasis of this course will be how to write proofs of different problems. Each proof will start with certain givens and unknowns, which the students will learn to solve following a series of statements on one column with the corresponding reason in the other column, leading to a logical conclusion. The final exam will have only one question that the students will have to solve with a multi-step and complex proof.

2. Geometry Course 2

- ☐ Geometry is the math of two- and three-dimensional shapes, and shapes are everywhere. How are houses built, parks designed, or GPS maps created? With geometry. This geometry course will help the student understand how angles, sides, perimeter, area, and volume for 2-d and 3-d apply to our lives. In the end, groups of three to four students will work together to design a high school athletic complex, including multiple sports fields, bleachers, and concession stands within the limitations of the space and materials provided.

**Part 3:** Rank the following biology learning materials from most to least interesting to you from 1-5. Use the number 1 to mark the most interesting learning material. Use the number 5 to indicate the least interesting.

- \_\_\_\_ Computer simulation programs
- \_\_\_\_ Plant and animal nurseries, aquariums, and cages
- \_\_\_\_ High tech lab equipment and tools
- \_\_\_\_ Team work stations
- \_\_\_\_ Containers of preserved animals and body parts

**Part 4:** Rank the following physics learning materials from most to least interesting to you from 1-5. Use the number 1 to mark the most interesting learning material. Use the number 5 to indicate the least interesting.

- \_\_\_\_ Computer simulation programs

- \_\_\_\_\_ Posters of famous physicists and their achievements
- \_\_\_\_\_ A variety of simple and complex machines
- \_\_\_\_\_ Team work stations
- \_\_\_\_\_ Electrical circuits

**Part 5:** Choose which of the following biology class activities that seem more interesting to you by checking **ONLY ONE** box in each group:

1.

- |   |   |
|---|---|
| <input type="checkbox"/> Mostly individual work, taxonomy, classifying parts of a cell, using microscopes, dissecting plants and animals. | <input type="checkbox"/> Mostly group work, growing and nurturing plants, designing virtual animals, reading and reporting science news, studying local ecosystems (e.g. ponds, rivers, and forests). |
|---|---|

---

2.

- |  |   |
|--|---|
| <input type="checkbox"/> Planting a sunflower seed in different soil mixtures and monitoring difference in the growth over time. | <input type="checkbox"/> Slicing a cross-section of a sunflower stem, placing it on a slide, and observing it under a microscope. |
|--|---|

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3.

- |  |   |
|--|---|
| <input type="checkbox"/> Cut open a butterfly's cocoon to see what it looks like in a specific point in the metamorphosis process. | <input type="checkbox"/> Watching the metamorphosis process from a caterpillar to a butterfly in a classroom butterfly observatory. |
|--|---|

---

4.

- |   |   |
|---|---|
| <input type="checkbox"/> Watching a video about how to prevent germs from spreading and how they are treated by antibiotics if they do infect a person. | <input type="checkbox"/> Watching a video about how germs intake nutrients, expel waste, and reproduce. |
|---|---|
-

**Part 6:** Choose which of the following physics class activities that seem more interesting to you:

1.

☐ Mostly individual work, assembling and disassembling complex machines, measuring objects with accelerometers and light sensors, experimenting on how physics affects inanimate objects.

☐ Mostly group work, researching how physics improves society, learning about lives of physicists such as Newton and Einstein, experimenting on how physics affects human bodies.

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2.

☐ Analyzing how the physics of airbags, seatbelts, and center of gravity saves lives in the event of car accidents.

☐ Taking a car engine apart to see how a combination of simple machines (e.g. levers, gears, wedges, wheels, and hinges) work together to make a complex machine.

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3.

☐ Comparing the number of stations and the amount of static between AM and FM radio stations a radio receives.

☐ Classifying the parts of a radio and the purpose of each of the parts.

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**Part 7:** I prefer lab work that emphasizes:

☐ Individual work

☐ Group work

### Peers

How many of your *male* friends are planning on attending college? \_\_\_\_\_

How many of your *female* friends are planning on attending college? \_\_\_\_\_

How many of your *male* friends are planning on majoring in the following science programs in college?



Biology\_\_\_\_\_

Chemistry\_\_\_\_\_

Geology\_\_\_\_\_

Health Science\_\_\_\_\_

Physics\_\_\_\_\_

Science Education\_\_\_\_\_

Engineering\_\_\_\_\_

Astronomy\_\_\_\_\_

How many of your *female* friends are planning on majoring in the following science programs in college?

Biology\_\_\_\_\_

Chemistry\_\_\_\_\_

Geology\_\_\_\_\_

Health Science\_\_\_\_\_

Physics\_\_\_\_\_

Engineering\_\_\_\_\_

Astronomy\_\_\_\_\_

Science Education\_\_\_\_\_

How many of your *male* friends are planning on majoring in the following math programs in college?

Business math (finance or accounting) \_\_\_\_\_

Statistics\_\_\_\_\_

Actuarial Science\_\_\_\_\_

Applied Math\_\_\_\_\_

Theoretical Math\_\_\_\_\_

Math Education\_\_\_\_\_

Computer Science\_\_\_\_\_

How many of your *female* friends are planning on majoring in the following math programs in college?

Business math (finance or accounting) \_\_\_\_\_

Statistics\_\_\_\_\_

Actuarial Science\_\_\_\_\_

Applied Math\_\_\_\_\_

Theoretical Math\_\_\_\_\_

Math Education\_\_\_\_\_

Computer Science\_\_\_\_\_

## College Plans

Are you planning on attending college?

Yes      No

If no, what do you plan to do after high school? \_\_\_\_\_

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In what area are you interested in majoring (check only one box)?

<u>Humanities</u>	<u>Science</u>	<u>Math</u>	<u>Fine Arts/Music</u>	<u>Social Science</u>
<input type="checkbox"/> English	<input type="checkbox"/> Chemistry	<input type="checkbox"/> Computer Science	<input type="checkbox"/> 2D/3D Art	<input type="checkbox"/> Sociology
<input type="checkbox"/> History	<input type="checkbox"/> Biology	<input type="checkbox"/> Actuarial Science	<input type="checkbox"/> Music	<input type="checkbox"/> Geography
<input type="checkbox"/> Foreign Language	<input type="checkbox"/> Geology	<input type="checkbox"/> Statistics	<input type="checkbox"/> Performance Art	<input type="checkbox"/> Psychology
<input type="checkbox"/> Religious Studies	<input type="checkbox"/> Physics	<input type="checkbox"/> Business Math (Accounting or Finance)	<input type="checkbox"/> Theater	<input type="checkbox"/> Health Sciences
<input type="checkbox"/> Cultural Studies	<input type="checkbox"/> Engineering			<input type="checkbox"/> Education

Other major not listed (please write)?

---

### Career

What career do you plan on having? \_\_\_\_\_

## Appendix E

### Pilot Interview Questions

Age: \_\_\_\_\_

Gender: \_\_\_\_\_

School: \_\_\_\_\_

#### Personal interests

1. Introductions
  - a. What's the highest level of math you've taken?
  - b. What's the highest level of science you've taken?
2. What is your favorite subject?
  - a. Why?
3. If you have to choose one type of science course, which one would you choose as your favorite?
  - a. What do you like about that subject?
4. If you have to choose one type of math course, which would you choose as your favorite?
  - a. What do you enjoy about that type of math?
5. In general, do you enjoy math? Science? Do you think you are good at math? Science?
6. If you could change anything about how math was taught to you, what would you change?
7. If you could change anything about how science was taught to you, what would you change?
8. Think of your favorite math teacher and what did that teacher do that made her/him your favorite teacher?
9. Think of your favorite science teacher and what did that teacher do that made her/him your favorite teacher?
10. The newest graduation requirements in Ohio increased the number of math credits needed to graduate from 3 to 4. Do you think this was a good change? Why or why not?

#### Gender perspectives

11. Who do you think is better at math, males or females?
12. Who do you think is better at science, males or females?
13. Most evidence shows males and females have the same STEM ability, but the college majors and careers are different. Why do you think more males choose

mathematically and scientifically demanding careers (such as engineering, computer science, and quantum physics) than females even though they seem to have the same ability?

#### Future goals and outlook

14. Are you planning on going to college?
  - a. What major are you thinking about?
  - b. Why are you thinking about college/that major?
15. What do you think you would like to do for your career?
  - a. What is the biggest reason for you to pursue that career: salary, job outlook, personal interest, parents, peers, or another reason?
  - b. In your perspective, how is math related to that career?
  - c. How is science related to that career?
16. In the future, which subjects or majors do you think will be most important for the types of jobs we will have 10 years from now?
17. What do you think is the most important subject for people who make a lot of money?
18. Who is your biggest role model or hero (parent, celebrity, scholar, older peer/sibling, politician, etc.)?
  - a. How does that person influence your choices or interests?

Thank you for your time. Do you have anything else to add or clarify? Do you have any questions for me? Enjoy the rest of your day. Bye.

## Appendix F

### Dissertation Interview Questions

Age: \_\_\_\_\_

Gender: \_\_\_\_\_

School: \_\_\_\_\_

#### **Part I**

##### Personal interests & background

1. Introductions
  - a. What's the highest level of math you've taken?
  - b. What's the highest level of science you've taken?
2. What is your favorite subject?
  - a. Why?
3. If you have to choose one type of science course, which one would you choose as your favorite?
  - a. What do you like about that subject?
4. If you have to choose one type of math course, which would you choose as your favorite?
  - a. What do you enjoy about that type of math?
5. In general, do you enjoy math? Science?
6. Do you think you are good at math? Science?

Gender perspectives on:

##### *Peers and Classmates*

7. Who do you think is better at math, males or females? Why?
8. Who do you think is better at science, males or females? Why?
9. Who participates more in math class, male or female classmates? Why?
10. Who participates more in science class, male or female classmates? Why?
11. What do you think is the biggest difference between your male and female classmates in STEM class? Why?

##### *Teachers*

12. Do you have any preference for the gender of your math teachers?
  - a. In your opinion, are male or female math teachers better and why?
  - b. Is your favorite math teacher a male or a female?
13. Do you have any preference for the gender of your science teachers?

- a. In your opinion, are male or female science teachers better and why?
  - b. Is your favorite science teacher a male or a female?
14. What do you believe is the biggest difference between male and female teachers?
  15. Does your current math teacher show or have any previous math teachers shown a preference for a certain gender? If so, what gender and why do you think the teacher or teachers had that preference?
  16. Does your current science teacher show or have any previous science teachers shown a preference for a certain gender? If so, what gender and why do you think the teacher or teachers had that preference?

Thank you for your time. Do you have anything else to add or clarify? Do you have any questions for me? Enjoy the rest of your day. Bye.

## **Part II**

### *Careers*

17. Most evidence shows males and females have the same STEM ability, but the college majors and careers are different. Why do you think more males choose mathematically and scientifically demanding careers (such as engineering, computer science, and quantum physics) than females even though they seem to have the same ability?
18. What changes need to be made to increase the numbers of females working in high-level STEM careers?
19. Can you name a famous male and female scientists and mathematician? Why did you select those individuals?
20. Do you think there are any qualities of each gender that makes them better at certain jobs? If so, what qualities?

### *Family and Peer Influence*

21. Do your parents or siblings ever talk about gender differences in STEM? If so, what kinds of things do they say about males or females?
22. Do you find yourself agreeing or disagreeing with your family's opinion of gender differences in STEM? Why?
23. How much do you think family beliefs affect whether a male or female chooses a math or science career?
24. Do your friends or classmates ever talk about gender differences in STEM? If so, what kinds of things do they say about males or females?
25. Do you find yourself agreeing or disagreeing with your peers' opinions of gender differences in STEM? Why?

26. How much do you think peer beliefs affect whether a male or female chooses a math or science career?

*Media Influence*

27. What gender stereotypes in STEM have you seen on television or in the movies?
28. Do you think the STEM gender differences in the media are mostly true or mostly false? What real-life experiences support or contradict the media representation?
29. Do you think media representations have a strong or weak effect on the STEM careers males and females choose? How might the media affect career decisions?
30. Who is the most positive female role model in math and/or science in the media? What makes her a good role model?
31. Who is the most positive male role model in math and/or science in the media? What makes him a good role model?

Thank you for your time. Do you have anything else to add or clarify? Do you have any questions for me? Enjoy the rest of your day. Bye.

**Part III**

Follow-up/clarification

1. (Are there any points I need to clarify from the previous interview?)
2. Do you want to change or add more to anything you discussed with me last interview?