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Achievement in Mathematics and Self-Concept Among Gifted Female High School Seniors

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ACHIEVEMENT IN MATHEMATICS AND SELF-CONCEPT

AMONG GIFTED FEMALE HIGH SCHOOL SENIORS

by

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CHAPTER ONE

Introduction

I have heard the phrase "I'm not a math person" more times than I can count. It rivals – or perhaps accompanies – declarations like "I can't do math," "I don't like math," and "I hate math." These reactions have been emphatic and immediate when I have mentioned that I teach math. Though I have come to expect them, it has always surprised me how readily people volunteer such sentiments. I cannot imagine people advertising that they cannot read.

Motivations and Inspirations

Students and adults alike have both asked me why I chose to teach math. More than one student has said, "You must *really* love math." In hindsight, I am not sure if my motives were noble or hubristic. I wanted to expand students' thinking and help them develop problem solving skills, self-confidence, and self-efficacy; to help students communicate effectively about math and collaborate with each other; and to show students that it is possible to be good at and enjoy math. After all, I enjoyed math and was also passionate about literature and the arts. I also wanted a challenge; I knew teaching math would be very challenging, given how polarizing it can be. I deliberately sought challenging teaching situations and a challenging subject, hoping to prove to myself that I could make an impact. I measured my self-worth by how successful or unsuccessful I felt I was in my endeavors.

While working at a camp called the South Dakota Ambassadors of Excellence during the summer of 2014, I was reminded of the dichotomous responses students have to math. This camp is for gifted high school students in South Dakota, and it is held on the campus of the University of South Dakota. The participants are called the Ambassadors. For two weeks, Ambassadors take classes offered by camp staff and university faculty and graduate students. Some of the classes offered include dance, art, and music performance, to philosophy, biology, and literature. Ambassadors spend several hours in rehearsal for a musical revue that they put on during the last night of camp. They also participate in teambuilding and leadership training in which they reflect on their experiences at camp, in school, and being gifted. They apply what they have learned and discussed while serving as mentors to the younger campers who arrive during the second week of the camp for the South Dakota Governor’s Camp.

I supervised a dormitory floor of female Ambassadors. During unstructured time in the evenings, I would talk with the girls. When they asked me what I did, I told them I had been a math teacher. That admission led to the sorts of instantaneous responses I had heard many times before, plus some others. Several girls shared their opinions about the Common Core Standards. One told me she was good at math but did not particularly enjoy or care about it. Another shared that she was not great at math and had to work really hard. She also said she would end up having to teach other students. I told her she probably had a better understanding of math than she thought, especially since she had to communicate her thinking to those she helped.

These discussions led me to further reflect on my experiences as both a student and a teacher. They inspired me to consider my research question: *What is the relationship between mathematics achievement and self-concept of gifted female high school seniors?*

This topic is significant in part because women are underrepresented in STEM careers. Stereotypes that males demonstrate more skill and inclination toward math and science persist. Exploring how gifted female high school students view mathematics and their level of mathematics achievement may provide insight into why even highly capable, high achieving young women seem to lack a connection or sense of purpose and excitement around mathematics and STEM careers.

This study focuses on high school seniors for several reasons. They are in the last year of the K-12 education system and thus have the greatest number and breadth of academic experiences to draw upon. They are also applying to college and making plans for their futures. Since they are in a time of both life and academic transition, they have a unique perspective regarding how their past experiences connect with their future endeavors and how the former have affected the latter. I am most interested in researching gifted female students because we share that identity even though we may or may not share experiences within it. Giftedness carries a unique set of challenges, and individuals within that population often share many psychological similarities, including fear of failure. The female subset of the gifted population combines these challenges with the cultural and gender norms of society at large. By exploring the intersection of these groups, I hope to better understand my own experiences in a larger context and further support gifted female students as best I can. To do so fully, I must retrace my steps, circumstances, and attitudes.

My Academic and Social Upbringing

I attended the same Catholic school from preschool through eighth grade. My class size went from 27 to 15 when several students moved to the town's public middle school. I was one of three students, and the only girl, who began the accelerated math track in seventh grade. The three of us took math with the eighth grade class, which was all female. The next year, we sat in the back of the room while our classmates had math instruction and taught ourselves algebra with negligible direct instruction.

I felt socially isolated from my female peers for a variety of reasons: I believed the girls in my class dumbed themselves down for the boys. I felt hostility from the girls in the class ahead of me. I believed that my intelligence and acceleration were not welcome in middle school, and I placed my sense of worth in my ability to earn good grades, do well on tests, and win awards. Simultaneously, I felt I had to keep my accomplishments to myself because one friend would guilt me for them, claiming that her parents would ask why she could not or did not do as well in school as I did.

In high school, I was grateful to have other girls in my math classes. Even so, I generally kept to myself. I remember a boisterous boy in my classes who would proclaim how easy our math tests were, and then even more loudly express his pleasure or displeasure in his score and whether or not he had done better than his friends. I am quite certain I almost always earned higher grades than he did, but I did not advertise and, as best I can recall, neither did any of the other girls. I was a member of the school math team, which competed once per year. The competition involved multiple-choice tests. For three of my four years on the team, I had the highest score on my team and ranked in the overall competition. I did not know of or participate in any other measures of math achievement beyond tests.

The arts also had a significant role in my upbringing. In kindergarten, I wanted to be a famous artist. (My mom will never let me forget my telling her that when I became rich and famous, I would put her in a home. I thought that would be a good, caring way to take care of her.) I grew up enjoying art and music. I played piano and French horn and sang sporadically. I won poster contests in elementary and middle school. I won ribbons at piano contests, from elementary through high school. My sense of worth came from these awards, but it was also tinged with that feeling from my peers that I always won, especially in the art contests. In high school, I was in band and participated in plays, oral interpretation, and debate but took no art classes until my senior year. I wanted to be at the top of my class in high school, so I enrolled in every accelerated and Advanced Placement course I could. An art class would not contribute to that goal. I dropped my open period to take a drawing and painting class, and I assembled a portfolio in less than one semester because I decided I wanted to go to art school and study fashion design.

I reconnected with my love of art outside of school. I attended several summer camps in middle and high school, including the South Dakota Governor's Camp and

Ambassadors of Excellence. I attended the Governor's Camp in 1998 and 1999, and I was an Ambassador from 2000 through 2002. The time I spent there was formative and affirming because I could be smart without being "the smart girl". I was not limited in what I wanted to try, and I could take risks like singing, dancing, and making art. I found support from the other campers. The energy and empowerment I felt there led me to embrace my artistic side again.

The chance I took on an art class and art school paid off. I received a scholarship that allowed me to attend my top college choice. There, I had opportunities to reconnect with my creativity while exploring new learning opportunities in other areas simultaneously. I remember being struck by the response I got from other students at my university when I told them I was in the art school. I did not fit their stereotype of an art student. Those responses resonated with me because I often felt a certain lack of intellectual accountability and stimulation in my studio classes. They also stuck with me because I grew up hearing people talk about art the way they did about math, saying, "I'm not creative"; "I can't draw"; "I can't sing"; "I'm not musical." Another dismissive response to art school was, "Oh, that must be fun." I bring this up because both math and art elicited similarly strong responses from others, who considered the two to be diametrically opposed. My ability and interest in both has always seemed to be anomalous. I enjoyed developing my artistic skills and knowledge of art history but – perhaps unsurprisingly – did not stay in the art school. I found an outlet and synthesis of my aesthetic and intellectual interests in costume design. It allowed me to interpret literature, research history and sociology, collaborate, and tell stories visually.

My interests and successes in math and art are indicative of my self-concept and experiences. I have felt different from both my peers and the general population in my love of learning and ability to achieve at high levels. I have not associated my giftedness with one specific type of intelligence; instead, I have long considered myself to be pretty good at a lot of things but not prodigiously talented at anything, including math and art. This could be because I am extremely self-critical, because I underestimate my own abilities, or both.

Conclusion

In this introduction, I have presented my research question: *What is the relationship between mathematics achievement and self-concept of gifted female high school seniors?* This question is significant because it may help both secondary schools and institutions of higher learning better address the under-representation of women in STEM careers. I hope to unearth students' perceptions and experiences of creativity and mathematics. The question may also inform our understanding of gifted female students both academically and psychologically. I have described my attitudes and experiences involving mathematics, the arts, and other subjects. My capstone will involve qualitative interviews with research participants to see what, if any, commonalities they share in their memories, experiences, and attitudes about mathematics, and how those students' achievement in mathematics affected their sense of self. The literature review in Chapter Two will focus on several key themes: definition and stereotypes of giftedness, gender norms and differences pertaining to mathematics, attitudes of malleable versus fixed intelligence and ability in mathematics, self-concept, and stereotype threat.

CHAPTER TWO

Literature Review

The research question, *What is the relationship between mathematics achievement to self-concept of gifted female high school seniors?*, has many components and possibilities to consider. The body of literature presents a variety of theories and methods to analyze data involving different aspects of giftedness and subsets of the gifted population. This literature review will focus on four key themes: definition and stereotypes of giftedness, gender norms and differences pertaining to mathematics, attitudes of malleable versus fixed intelligence and ability in mathematics, and academic and social self concept.

Definitions

This study requires definitions of a few key terms. The online Oxford Dictionary (http://www.oxforddictionaries.com/us) offers the following definitions: achievement can be considered "a thing done successfully, typically by effort, courage, or skill." Due to the open-ended nature of questions posed to research subjects, this definition allows for interpretation of it and its outcomes, namely success and failure, by participants. Also, Oxford defines self-concept as "an idea of the self constructed from the beliefs one holds about oneself and the responses of others."

Giftedness may not be so easily defined. Foley-Nicpon, Assouline, Rickels, and Richards (2012) noted that, while the *Diagnostic and Statistical Manual of Mental*

Disorders (2000) defines attention deficit hyperactivity disorder (ADHD), it does not define giftedness. Instead, “qualifying for gifted programs is typically based on a local school district’s definition of giftedness” (p. 223), based on the broad federal definition in the Elementary and Secondary Education Act to identify gifted students as:

> … students, children, or youth who give evidence of high achievement capability in areas such as intellectual, creative, artistic, or leadership capacity, or in specific academic fields, and who need services and activities not ordinarily provided by the school in order to fully develop those capabilities (U.S. Department of Education, 2002, p. 544).

For the duration of this study, the above will serve as the working definition for giftedness.

The definition leaves ample room for interpretation, especially regarding evidence, capability, capacity, and need. Gardner’s (1993) theory of multiple intelligences (MI) broadened notions of intelligence beyond verbal and computational to include spatial, musical, bodily-kinesthetic, and other abilities.

Stereotypes of Giftedness

The nebulous definition of giftedness can result in stereotypes. Because teacher recommendations tend to be a key aspect of inclusion in gifted programs, Carman (2011) used qualitative and quantitative data analyses to differentiate the levels of stereotypic thinking about gifted individuals among 91 undergraduate and 20 graduate education majors at a large Midwestern university. Carman shared,

> Common stereotypical thoughts about the gifted include that giftedness occurs more often among Caucasians and males, that gifted individuals enjoy learning about science and/or math more than any other subjects, that gifted individuals display talents in general intellectual ability and/or specific academic aptitude more than any other talent area (including creativity, leadership, and visual or performing arts), and that giftedness occurs most commonly in children and adolescents, as opposed to adults (p. 798).

Many of these stereotypes may become self-fulfilling prophecies, given that teacher recommendations most significantly impact inclusion in gifted programs.

These stereotypes may pose great harm to gifted students, whose identity as gifted and academic self-concept may be undermined or discounted because they do not fit such inaccurate but ubiquitous notions. Coleman and Guo (2013) examined the role of passion for learning (PFL) in the domains of acting, reading, filmmaking, spelling, math, and preaching. Seeking to investigate the genesis of passion and noncognitive factors in talent development, they used various qualitative interview and observation methods to examine one individual, age five-15, for each of the domains. They noted,

> No one denies that ability is an important factor in development of talent, but the way noncognitive factors are related to giftedness and talent has been misunderstood and misused. … Ability-first orientation has been used in a perverse way in the identification process to exclude high-achieving children … Sometimes, these children are called pejoratively, teacher pleasers. It is odd that a successful learner might not be permitted into a program (p.158).

These concerns drove the authors' research of PFL, because they wanted to "understand children who achieve well in a domain and at the same time do not meet our procedures for being considered gifted" (p. 158).

Stereotypes of giftedness impact both the academic and social self-concepts of students. "78.8% [of research participants] held stereotypical thoughts about four or more of the following areas: gender, ethnicity, age, learning interests, talents, and use of glasses" (Carman, 2011, p. 799). Of the 84 preservice and 20 in-service teacher participants, 81% and 70%, respectively, held such stereotypic thoughts. Categories that emerged from Carman's study were: physical, personality, interpersonal relationships, and interests. Although personality and interpersonal relationships were least frequently mentioned, research participants "were almost twice as likely to report that their imaginary gifted person was not popular among their peers" (p. 803). It is possible that teachers dismiss gifted students' need for belonging because those students might not fit in among students in the larger classroom and school settings. The alienation that gifted students may experience adversely affects their social self-concept.

Giftedness carries the stress of internal and external expectations. "It cannot be assumed that a student feels positively about himself and his abilities just because he or she is identified as gifted. … Educators should not rule out the potential for a negative self-esteem just because a student is identified as gifted" (Foley-Nicpon et al., 2012, p. 233). As Coleman and Cross observe, "the academically gifted are expected to be able to do everything well, and when they don't, they are rebuked" (2014, p. 7). Postulating that students would articulate feelings of difference and recognized giftedness interfering with social acceptance, the authors interviewed 99 gifted high school students, age 15-17, attending a special summer program. Internal pressures may compound those from others. Tippey and Burnham (2009), who used the American Survey Schedule for Children, adapted from the Australian Fear Survey Schedule for Children-II, to study the fears of 287 gifted students aged 7-10, note that gifted children tend to be extremely self-critical, seeing their potential, “berating themselves because they see how they are falling short of an ideal” (p. 321). Because of these expectations, particularly the external ones, students may try to downplay their giftedness. Gifted students can maintain low visibility by choosing not to acknowledge their accomplishments or admit when evaluations are easy (Coleman & Cross, 2014).

Gender Differences and Math/STEM

Gender Differences and Gender Typing. Gender differences and norms relating to science, technology, engineering, and math (STEM) are ubiquitous. Even Laurence Summers, then President of Harvard University, at the National Bureau of Economic Research (NBER) Conference on Diversifying the Science and Engineering Workforce, claimed that genetic differences accounted for males outperforming females in math and science (2005). Malin and Makel (2012) paraphrased gender typing, part of Gottfredson’s (1981, 2005) theory of circumscription and compromise, as “a gendered association of academic subjects, activities, and occupations” (p. 176). Examples of gender typing include that males like and excel in math and science, while girls like and excel in language, visual, and performing arts. Though society seems to have become more open to both genders exploring these and other interests, these stereotypes persist. The authors also cited research by Su, Rounds, and Armstrong (2009) revealing that a comparative majority of adult men (82.4% over women) prefer working with things, while adult women (74.9% over men) prefer working with people (p. 176). The study reiterates the gender typing of boys' enjoyment of construction and toys, versus girls' enjoyment of pretending games like "house" or "school." The authors further related this research to expectancy-value theory, developed by Eccles et al. (1993), which blends competency beliefs with subjective task value (Malin & Makel, 2012). The examples listed, combined with myriad other commonplace gender typing, instill in young children the notions of what they can and should enjoy and excel.

Gender Differences in Problem Solving. Gender typing may contribute to the types and language of problems gifted students choose to solve. Malin and Makel's research (2012) investigated gender differences in problem solving approaches and framing by asking 277 gifted students in grades 5-6 to pretend to advise the president to solve the nation's most important problem. Key differences emerged in the types of problems students chose: Male students focused on issues of terrorism and safety, while female students focused on other issues like the environment and animal welfare. Another notable difference was the language students used: Male students used "restore" phrases, suggesting a return to former glory. Female students used "improve" phrases, suggesting the possibility for progress. These differences suggest gender value differences.

Gender differences did not emerge in other areas of Malin and Makel's study (2012). Gifted female students showed no advantage or significant differences from males in writing scores, though previous assessments had shown consistently higher scores for females over males generally. The authors' research did not support their hypothesis that female students would use more emotional than fact-based arguments compared to males; nor did any "people" versus "things" gender differences emerge in their sample.

Gender Differences in Achievement Levels and Attitudes. Gender typing may relate to achievement levels and attitudes of gifted students. Abu-Hamour and Al-Hmouz (2013) studied a sample of 197 gifted students in grades 10 and 11 from an academically selective high school in New South Wales. They used two standardized tests to assess explanatory variables of gender and achievement in English and math, response variables of motivation, self-regulation, and attitudes toward school and teachers, and the differences that emerged among students of varying achievement levels. Their study yielded significant differences, especially between gifted high and low achievers in math, in mean scores on 12 factors of motivation, self-regulation, and attitudes. Among the various achievement groups in language, however, mean scores showed no significant differences. The authors found that high and moderate achievers in math had more positive attitudes toward school and teachers and that intrinsic motivation could best predict math achievement. They also noted key differences between male and female students: Females had lower mean scores than males on all factors except organizational skills, with significant differences in motivation average, intrinsic and extrinsic motivation, and critical thinking.

Gender Differences in Spatial Ability. Gender typing may also impact spatial reasoning and ability, which are integral to mathematics and in STEM fields. As Coxon (2012) noted, innovations in STEM fields improve society's quality of life. Coxon's study used participation in a LEGO robotics contest simulation as a treatment for development of spatial ability among 75 students aged nine to 14 in public school districts' gifted programs. The authors studied the outcomes of the experimental and control groups, which both included any available females and students from populations underrepresented in gifted programs. Female students showed no significant gains in spatial ability, for which the author offered several possible rationales, including gender norms or differences in spatial ability and physiology and predominantly male interest in participation in the study. Coxon also observed that the male and female participants had similar pretest scores but different post-test scores in the abstract reasoning component of spatial ability, which suggested that different treatments might develop different facets of spatial ability and that male and female students might respond differently to gendered activities.

Attitudes of Malleable vs. Fixed Intelligence and Ability in Math

An attitude of malleable intelligence may be most valuable and, frustratingly, most absent among students learning math. "I'm not a math person" and "I can't do math" often coincide with declarations like "I hate math." These statements result from negative experiences with a particular math concept or teacher and become intellectually and emotionally debilitating self-fulfilling prophecies. The theme of malleable versus fixed intelligence has numerous iterations in the body of literature about giftedness and mathematics. By examining the contributing factors and manifestations of gifted students' mindsets in the classroom, we seek to improve their learning experiences.

Passion for Learning. In Coleman and Guo's study (2013), the student with a passion for learning math gained momentum as he experienced the challenge and beauty of problem solving. He did not memorize but rather proved formulas, which allowed him to implement and adapt them as needed. He revisited problems he had already solved to move from "brute force" (p. 165) to the most elegant solution. That winnowing process may not have occurred without his willingness to take risks, make mistakes, and explore creative and mathematical possibilities. According to Cox (1926), as cited by Coleman and Guo (2013), noncognitive factors in talent development include motivation, persistence, and determination. The student with a PFL in math recognized his own passion and received positive feedback, which fostered his academic and talent development via those noncognitive factors.

Creativity. Creativity is multifaceted. Lemons (2011) viewed creativity through five lenses: person, product, environment/press, process, and passion. A creative person shows a lack of inhibitions and a work toward self-actualization. A creative product has novelty, originality, and utility, among other qualities. A creative environment involves "training, collaboration, dialogue, and listening" (pp. 758-759). A creative process falls into one of five categories: "cognitive-developmental (creativity develops through stages), gestalt (restructuring), psychoanalytical (exploring the subconscious), associationist (making connections), and humanistic (when individuals holistically integrate all their experiences)" (p. 757). A creative passion is an intrinsic motivation.

These lenses of creativity are valuable in reframing math experiences and education, as most students do not recognize or seek the creative opportunities math presents. Many students consider artistic endeavors to be diametrically opposed to math, when in fact creativity is as much a part of math as of the arts. In fact, creativity has "widely diverse characteristics across numerous domains that extend beyond the traditional fields of the visual and performing arts" (Lemons, 2011, p. 762), just as domains of giftedness extend beyond stereotypes of math and science. And while teachers may overlook high achievers who do not demonstrate natural ability, those same teachers may also overlook highly creative low achieving students. Thus, many students continue to miss the opportunities gifted programs afford.

Creativity in Math. Creativity is a valuable motivator in math education. Matsko and Thomas (2014) studied the effects of creativity in mathematics by having high achieving math students create "original mathematics problems in their area of interest" (p. 157). The treatment assignment had four parts:

1. Students had to identify the source of motivation for the problems they generated.
2. Students had to create a problem statement.
3. Students had to create the problem solution.
4. Students had to reflect on their problem and the process of creating it.

It is important to note that students were not supposed to create problems they thought would be engaging or motivating to others, only problems that enticed each student personally. Students demonstrated "the need for challenge, interdisciplinary thinking, and transfer to real life and feelings of competence" (Matsko & Thomas, 2014, p. 161).

While students did not recognize any enhancement of motivation in their math learning, the problems they created showed evidence of challenge and curiosity enhancing their motivation, metacognition, and transfer of skills. The freedom of creating their own problems allowed students to create personally meaningful mathematical situations. Students were engaged, self-regulated, and autonomous, which positively affected their motivation and reconnected them with the joy and fun of mathematics (Matsko & Thomas, 2014).

Mathematical aptitude has many components. Krutetskii (1976), as cited by Coxbill, Chamberlin, and Weatherford (2013), delineated nine ways of thinking that distinguish advanced students from their average peers; these include the abilities to formalize and generalize mathematical material, operate with numerals and symbols, demonstrate "sequential, properly segmented logical reasoning" (p. 178), shorten the reasoning process, reverse mental processes, switch between mental operations, grasp spatial concepts, and having a mathematical memory. Coxbill et al. tested model-eliciting activities (MEAs) as tools to identify mathematically creative students by examining the group written products from 39 students in grades 3 and 6. Krutetskii's ways of thinking embody the facility necessary to approach and think about math creatively. Certainly,

> … it may be rare for mathematically advanced, creative students to possess all of the nine ways of thinking. … Although ideas about mathematically creative students are diverse, most experts convey one notion: Creative students can

> manipulate mathematics in ways that are innovative and reusable (Coxbill et al., 2013, p. 178).

The combination of innovation and reusability seems to be key. Algorithms are reusable but not innovative; they lend themselves to rote practice and regurgitation of procedural steps modeled by a teacher. Ephemeral innovations that cannot be shared, transferred, or reused are of little value in the social setting of the classroom or the technological developments beneficial to society.

Math does not exist in a vacuum academically or socially. Too often, though, students feel alienated by their math education experiences. Perhaps for this reason, the U.S. Department of Education (2003), as cited by Coxbill et al. (2013), found that students' positive attitudes about math drop 46% between grade four and grade eight.

> Teacher-centered instruction and traditional classroom frameworks rarely provide the opportunity for students to display (their) unrecognized talents. In such settings, students' creativity may be quashed by requirements to use the methods or strategies that are presented by the teacher. Moreover, an unnecessary emphasis on speed in computation may be counterproductive to identifying mathematically creative students (Coxbill et al., 2013, pp. 192-193).

The situation Coxbill et al. describe relates to teachers' stereotypes of giftedness discussed earlier.

<u>Engagement.</u> Student engagement is a prerequisite to student learning. Landis and Reschly (2013) reviewed the body of literature around gifted underachievement and dropout and their relationship to student engagement. They described four types of

engagement: Academic engagement, measured by time on task and homework completion; behavioral engagement, evident in preparation for class and study skills; affective engagement, dependent upon relationships with teachers, peers, and parents to foster a sense of belonging; and cognitive engagement, which is the personal value placed in school.

Messiness. Seeking to broaden "gifted high school students' appreciation of the nature of mathematics and of philosophy in general" (p. 90), McMaster and Betts (2007) developed a math unit exploring messiness. Though they did not offer a precise definition of messiness, they explained, "Messiness highlights the uncertain, social, contextual aspects of school mathematics" (p. 89). Messiness could be considered similar to productive confusion. They implemented the unit in an International Baccalaureate Theory of Knowledge (ToK) philosophy class comprised of gifted high school students. They explained, "Teachers respond to messiness with, 'you'll learn how to deal with this in more advanced math classes.' … [Students] often passively accept the answer of a smarter student, the teacher or the textbook" (p. 91). Many math classrooms may miss out on opportunities for exploration, discovery, and interpretation of math concepts and theory. Even in higher-level classes like calculus, students can fall into the old routine of rules and formulas rather than develop a dynamic and deep understanding of the significance and power of the discipline.

McMaster and Betts (2007) expressed the "hope that students appreciate the processes involved, rather than only be exposed to the polished final presentation of mathematics found in school math textbooks" (p.92). Students explored roots of negative numbers and infinities of and between real numbers. The topics they chose were rife with contradictions, paradoxes, and big ideas that could spark questions and discussions. They identified three groups of student reactions to the exercises:

1. Students who did not consider themselves good at math and lacked positive math self-concepts felt the course of study did not “make sense” and felt anxious, unprepared, and unworthy to engage in deeper discussion of mathematics.
2. Students who professed a dislike for math, regardless of their individual ability, would not willingly engage in discussions about math or math philosophy.
3. A small group of students who enjoyed and considered themselves good at math was fully engaged and enthusiastic about exploring and discussing the problems.

Many students’ focus on right or wrong answers preempted their engagement in nuanced concepts and their opportunity to gain deeper understanding (McMaster & Betts, 2007).

These findings exemplified the difference between performance and mastery learning. Heilbronner (2011) administered a survey to 360 Science Talent Search semifinalists and finalists to better understand factors contributing to individuals’ declaration of STEM college majors, finding that students’ motivation and tenacity depend on their learning goals:

> Performance learners – learners who view the goal of learning to be successful performance (e.g., good grades) and fear failure – may not persist in the face of difficulty, whereas learners who view the goal of learning to be mastery of skills or content – mastery learners – do tend to persist (p. 880).

Fear of failure may be common among gifted students, especially if they are focused on performance rather than mastery.

Where does a student's passion and desire to learn originate? Coleman and Guo (2013) defined *passion for learning* (PFL) as "focused interest, which persists over lengthy periods of time and is associated with relative disinterest toward more typical interests of same-age peers" (p. 157). Passionate learning and passion for learning are not equivalent. While passionate learning may lead to passion for learning, the converse is rarely true. A student with a strong interest in one area does not apply that same intensity and focus to all other study. The authors commented on the significance of social context in developing PFL:

> Social context also refers to recognition of the child's PFL by others outside the family. For at least five of the participants, in addition to the thrill of learning or mastery they experienced, the participants seemed to perceive a payoff from pursuing their passion. In the speller (Betty) and for the mathematician (Dom), competition was stimulating (p. 169).

Thus, extrinsic rewards and positive acknowledgement validated these students' academic self-concepts but did not drive their passion. While different passions manifested at different ages among research participants, "…for the mathematician and the reader, attraction occurred when the skills were evident" (pp.170-171).

In an effort to explore integration of the arts and use of technology in math, Gadanidis, Hughes, and Cordy (2011) engaged 32 gifted students in grades seven and eight in open-ended math tasks incorporating both, partially online and partially in a classroom setting. They found that gifted students who did well in math did not consider it their favorite subject, instead preferring subjects like language arts and drama, "…which provided project-based learning and opportunities for personal expression" (p. 421). The authors also noted that these students' "mathematical knowledge tended to be narrow and procedural, rather than conceptual" (p. 421). While math is complex and dynamic, students may not experience the subject that way. Students may not see math as open to interpretation, in part because they may not get the chance to engage in its conceptual foundations.

Self-Concept

Self-concept is "our attitudes, feelings, and knowledge about our abilities, skills, appearance, and social acceptability" (Byrne, 1984, p. 429). Factors including social support and dynamics and stereotypes influence self-concept (Rinn, Reynolds, & McQueen, 2011). Self-concept, in turn, may impact academic performance and motivation.

Social Support. Social support is invaluable to helping gifted female students cope (Rinn et al., 2011). Using the Self-Description Questionnaire II and the Child and Adolescent Social Support Scale, the authors studied the relationship between perceived social support and self-concept among 217 gifted students who had completed grades 5-10. The absence of social support may result in "decreased self-concepts, among other academic and socioemotional consequences. Further, males and females may need social support from different sources or in different combinations (e.g., from parents and teachers, rather than from friends)" (p. 373). These support combinations affect how female students act and interact in and out of school:

> Results indicated gifted adolescents fell into three groups, or clusters, based on their perceived sources of support, or the lack thereof, namely a High Parent/Friend, Low Teacher/Classmate group, wherein individuals appear to get their support outside of school; a High Parent/Teacher, Low Classmate/Friend group, wherein individuals appear to get their support from adults, not peers; and a High Friend, Low Parent group, wherein individuals do not seem to be affected by school-related support, but draw the most support from their friends (p. 387).

It seems likely that the most successful students receive support from a variety of people. With the goal of examining the extent of differences in self-concept among gifted students across grade and gender, Rudasill, Capper, Foust, Callahan, and Albaugh (2009) had 260 students in grades 8-11 complete the Self-Perception Profile for Adolescents and 300 students in grades 5-7 complete the Self-Perception Profile for children. They note, "attempts to create environments where females come to see themselves as positive actors in their own lives and to evaluate themselves positively seem to be limited in some respects" (p. 361). The social dynamics gifted female students encounter, through grouping or advanced classes, reflect these observations and the need for more empowering environments.

Effect of Grouping on Self-Concept. Advanced or accelerated classes provide students with unique opportunities for learning. Preckel and Brüll (2008) sought to analyze the impact of ability grouping on self-concept among 211 German students in grade level 5. The authors assessed both students enrolled in regular classes and students in special gifted classes using self-report questionnaires and a standardized IQ test. They found "full-time ability grouping in special classrooms" (pp. 54-55) most benefits high-ability and gifted students' academic achievement but often undermines their academic self-concept. This contrast or big-fish-little-pond effect (BFLPE) is disconcerting because academic self-concept affects academic achievement, interest, and emotions like test anxiety. Alternately, when placed in a high-ability group or selective class, students may experience an assimilation or reflected-glory effect that improves their academic self-concept. Put another way, students may feel a certain pride to be in such a group and rise to the occasion.

Ability grouping has interesting impacts on gifted females' self-concept. "Although females in the gifted classes earned better grades than males, both genders reported a comparable mean level of academic self-concept" (Preckel & Brull, 2008, p. 59), suggesting that girls tended to underestimate themselves and their abilities. Further, gifted girls' academic self-concept decreased as the percentage of boys in class or female minority status increased (Preckel & Brull, 2008). Minority status could contribute to anxiety related to stereotype threat.

Stereotype Threat

Stereotype threat can impact individuals' academic performance and self-concept. Steele and Aronson (1995) defined stereotype threat as "being at risk of confirming, as self-characteristic, a negative stereotype about one's group" (p. 797). They tested the vulnerability of ability-stigmatized groups to stereotype threat by having 117 Black and

White Stanford undergraduate students take a difficult verbal test and dividing participants into groups under an ability-diagnostic condition and a nondiagnostic condition. Skaalvik and Skaalvik (2004) administered a self-description questionnaire to 907 Norwegian students in grades six, nine, 11, and the first year of senior high school to examine gender differences in math and verbal self-concept, performance expectations, intrinsic motivation, and goal orientation. They identified differences in math self-concept and performance expectations; those differences emerged in elementary school and continued into adulthood. Fogliati and Bussey (2013) wanted to explore how female-mathematics stereotype impacted females' performance, response to negative feedback, and motivation to improve. The 80 study participants, all college students, 54 of them female, were split between the conditions of stereotype threat and no stereotype threat. They found that female-mathematics stereotype can both impair performance and lower motivation among women, which may cause them not to seek opportunities to improve their skills and performance.

The sources and ramifications of stereotype threat vary. Shapiro and Williams (2011) distinguish between self-as-source and other-as-source stereotype threats: The former suggests an individual's fear of confirming herself to be an example of a negative stereotype or confirming her fears that the stereotype is true. The latter suggests an individual's fear that poor performance will confirm the stereotype to others, like teachers or parents, who may judge or treat her less favorably. Interestingly, "distinct from self-as-source stereotype threats, for other-as-source stereotype threats to emerge, one does not need to believe the stereotype could be true… [but] must believe that *others* endorse these negative stereotypes" (p. 379). Female students may feel pressure to perform well in order to contradict the negative stereotype and represent women in a more positive way. The subsequent anxiety may undermine their performance.

Lesko and Corpus (2006) mention several types of ego-protective responses to stereotype threat, including "disidentification, disengagement, and self-handicapping" (pp. 114-115). To see how math identity affects females' response to math gender stereotypes, authors had male and female college students with different levels of math identification take a difficult math test after stereotype threat was activated or nullified. The responses they describe emerge among individuals who have not or do not expect to experience success, though, and thus are not likely among high math-identified women, who plan to continue in the field of mathematics. The authors instead focused on individuals' discounting the validity of evaluations, which would still allow identification with the domain. The women who participated in the study only exhibited the discounting response when under stereotype threat, and the response showed no connection to posttest self-esteem or domain identification.

Gresky, Ten Eyck, Lord, and McIntyre (2005) investigated how women's reflection and documentation of their identities impacted their math performance under stereotype threat. To test the hypothesis that identifying multiple roles and identities might alleviate individual women's math stereotype threat, the authors primed the stereotype and asked 129 college students (94 women and 35 men) to draw self-concept maps with many or few nodes. The experiment involved both men and women; researchers explicitly communicated to subjects the stereotype that men outscore women on the quantitative portion of the Graduate Record Exam (GRE) to induce stereotype threat, "especially for women who identified with and cared about the domain of mathematics" (p. 711). Prior to taking a test with difficult items from GRE sample tests, subjects were divided into three groups: The first group created self-concept maps with few nodes, incorporating only what subjects considered to be the most important characteristics with minimal connections. The second group created self-concept maps with many nodes, incorporating ample information with multiple, hierarchical connections. The third created no self-concept maps and took the test. "Highly math identified women" (p. 711) who created either no self-concept maps or ones with few nodes scored worse than men with the same math identity, while those women who created self-concept maps with many nodes scored much better, with scores comparable to men. The disparity in these outcomes suggest that when these women identified highly detailed contexts and characteristics of their lives and themselves, their math achievement and ability carried less weight in determining their self-concept. Stereotype threat did not hinder their ability to perform well on the test or increase their anxiety to do so.

Conclusion

This chapter has focused on several key themes: definition and stereotypes of giftedness, gender norms and differences pertaining to mathematics, attitudes of malleable versus fixed intelligence and ability in mathematics, self-concept, and stereotype threat. The body of literature addresses many elements of and experiences surrounding these topics. While ample research exploring how students experience giftedness, how gender typing affects attitudes about mathematics, and how personal attitudes and stereotype threat impacts achievement and self-concept, more room for exploration exists. The research question, *What is the relationship between mathematics achievement to self-concept of gifted female high school seniors?*, seeks to investigate the nuances of this relationship. Qualitative research can contribute to the body of literature by focusing on more nuanced dynamics of female experiences of giftedness within and outside of mathematics and their impact on self-concept. The experiences and reflections of research participants may unearth aspects of learning, mathematics, creativity, and giftedness that would help female students feel more empowered, excited, and supported in their learning endeavors in and beyond mathematics. Those intangible elements may become more actionable with further research.

CHAPTER THREE

Methods

Research Question

What is the relationship between mathematics achievement and self-concept of gifted female high school seniors?

Research Paradigm and Method

The study's paradigm is primarily qualitative. Creswell (2009) defines qualitative research as

> … a means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem. The process of research involves emerging questions and procedures; collecting data in the participants' setting; analyzing the data inductively, building from particulars to general themes; and making interpretations of the meaning of the data. (p. 232)

I chose a qualitative approach because academic self-concept is not necessarily quantifiable and is, I believe, best explored through stories instead of tests. I also chose a qualitative approach because the factors impacting academic self-concept of gifted female students are myriad. The more I attempted to narrow the factors and variables, the more I felt I would miss or neglect something in participants' stories.

My primary research instrument was an in-depth, open-ended questionnaire, and I hoped to develop a grounded theory of academic self-concept of gifted female high school students based on participants in South Dakota. I believed this would be the most effective strategy because it would best compare questionnaire data with anticipated and emergent themes (Creswell, 2009, p. 13). My questionnaire protocol would facilitate the strategic process of grounded theory through open-ended questions (Mack, Woodsong, MacQueen, Guest, & Namey, 2005, pp. 3-4).

Setting

The study was conducted remotely because students are scattered throughout the state of South Dakota. Participants answered interview questions via an online survey; they completed it at school, at home, or at another location with internet access. The survey was open for approximately four weeks. Participants were not required to complete all questions at one time.

Participants

Individuals invited to participate in the study were female high school seniors (2014-2015) who had attended the South Dakota Ambassadors of Excellence summer program at the University of South Dakota. The camp is for gifted high school students; admittance is based on "demonstrated talent, leadership, active participation in school, and high academic success" (26^{th} Annual Ambassadors of Excellence Program brochure, 2014). Students must also have the recommendation of a faculty member from their school.

The 20 female students eligible for participation in my study reside and attend high schools throughout the state of South Dakota. They reside in rural communities, small towns, and small cities. They were predominantly Caucasian, though a few were Native American and/or African American. They must be 18 years old to participate in the study. I did not determine which participants qualify for free or reduced lunch programs. I contacted the 20 prospective participants through Facebook to attain their email addresses to distribute letters of consent. Of the 20 I contacted, 18 responded. Of those 18, five returned letters of consent.

I worked with the five young women at the South Dakota Ambassadors of Excellence summer program. I developed positive working and personal connections with many of them through that experience. As such, this study fit the definition of “backyard” research given by Glesne and Peshkin, 1992 (as cited by Creswell, 2009, p. 177). While my connection with research participants might be problematic for reporting data, I hoped my rapport with them would help them to feel safe and be honest in sharing their experiences and perceptions around the research question.

<u>Participant Profiles.</u> My efforts to secure research participants had several steps. I reached out to 18 girls via Facebook in search of email addresses to send invitations to participate and letters of consent. Of the 18 girls contacted, 16 responded. Of those 16, five signed and returned letters of consent: Laura*, Jessica*, Erin*, Marissa*, and Ashley* (names have been changed). Each participant came from a different town in South Dakota. According to the United States Census Bureau, the state’s population was estimated at 845,500 in 2013. The state population, according to the 2010 census, is

85.9% White alone, 1.3% Black/African American alone, 8.8% American Indian/Alaska Native alone, 0.9% Asian alone, and 2.7% Hispanic/Latino, with 2.1% of the population self-identifying as two or more races.

Laura lives in Sioux Falls, located in southeastern South Dakota. With a population estimated at nearly 165,000 people in 2013, it is the largest city in the state. The population is 86.8% White, 4.2% Black/African American, 2.7% American Indian/Alaska Native, 1.8% Asian, and 4.4% Hispanic/Latino, with 2.5% self-identifying as two or more races. Laura identifies as White. She graduated from one of three public high schools in the city, which also has two private, religiously affiliated high schools. Her school has approximately 2,000 students in grades 9-12. Her grade point average (GPA) was 3.8. Her ACT composite score was 32, with 29 in math. Her highest math course was advanced placement (AP) statistics.

Jessica lives in Belle Fourche, located in western South Dakota, near the Wyoming border. The town's population was estimated at approximately 5,700 people in 2013. Its population is 93.6% White, 0.2% Black/African American, 2.1% American Indian/Alaska Native, 0.3% Asian, and 4.1% Hispanic/Latino, with 2.6% of the population self-identifying as two or more races. Jessica identifies as White. Jessica graduated from the town's primary public high school (one of two), which has approximately 350 students in grades 9-12. Her GPA was 4.17. Her highest math course was AP calculus/college algebra. She received a composite ACT score of 28, with a math score of 30.

Erin lives in Aberdeen, located in northeast South Dakota near the Minnesota and Iowa borders; its population was roughly 27,500 in 2013. Demographically, 91.8% of Aberdeen's citizens are White; 0.7% are Black/African American; 3.6% are American India/Alaska Native; 1.3% are Asian; 1.6% are Hispanic/Latino. 2.0% of the population self-identify as two or more races. Erin identifies as White. She graduated from the town's predominant high school, which is public and has nearly 1,200 students in grades 9-12. Her GPA was 3.96 (unweighted); her ACT composite score was 33, with a score of 25 in the math subset. The highest math course she completed was advanced math (trigonometry).

Marissa lives in Vermillion, near the Iowa and Nebraska borders. The town's population was estimated at approximately 10,700 people in 2013. Its population is 89.6% White, 1.7% Black/African American, 3.6% American Indian/Alaska Native, 2.1% Asian, and 2.4% Hispanic/Latino, with 2.6% of the population self-identifying as two or more races. Marissa identifies as both White and Black/African American. Vermillion has one public high school with roughly 350 students in grades 9-12. Marissa, however, was home schooled after eighth grade and completed the test for her General Education Diploma (GED) in 2014. Her GED subset scores were within the 97-99th percentile; her math score was in the 58th percentile. The highest math course she completed was precalculus. Her GPA was 3.7.

Ashley lives in Rapid City; South Dakota's second-largest city; it is the largest city on the western side of the state. Its population in 2013 was roughly 70,800. The city is 80.4% White, 1.1% Black/African American, 12.4% American Indian/Alaska Native, 1.2% Asian, and 4.1% Hispanic/Latino, with 4.1% of citizens self-identifying as two or more races. Ashley identifies as White and graduated from the city's private Catholic high school, which has nearly 250 students in grades 9-12. Ashley was not able to finish the entire questionnaire due to logistical and scheduling challenges.

Methods and Tools

I intended to use multiple methods and tools in my research. I planned to use an online questionnaire in lieu of, but with the same intent as, interviews. Because I focused on participants' academic and social self-concepts, the perceptive filter of interviews aligned with my intent (Creswell, 2009, p. 179). I recognized that interviews, both generally and online, have limitations, but I did not have the opportunity to observe or conduct interviews in person because of time, financial, and logistical constraints.

The questions and topics I discussed were organized around several themes. The first sentence of each bullet point is the guiding question, with subsequent follow-up questions. These questions included:

1. Describe/rate your math skills/ability and your enjoyment of math. Explain how you arrived at those ratings.
2. Do you believe your skill/ability determines your enjoyment, or your enjoyment determines your skill/ability? Why do you think that is?
3. Compare/contrast your favorite and least favorite math classes. Share any specific memories/examples to elucidate why you liked/disliked those classes.
4. Compare/contrast your favorite and least favorite math teachers. Share any specific experiences/characteristics that stood out to you about those teachers.

5. Discuss your earliest feeling of success and/or failure in math. How did you know you were successful? What did success feel like? What made you think you failed? What did failure feel like?
6. Share your most recent feeling of success and/or failure in math. How did you know you were successful? What did success feel like? What made you think you failed? What did failure feel like?
7. How do you consider yourself to be a creative person? What draws you to your creative passions/outlets?
8. Talk about when you have had opportunities to be creative in math.
9. Do you or have you ever considered your gender to be an asset or a liability to you in your math classes? Why or why not? Describe an experience in which being female felt like an asset and/or a liability in your learning.

Data Analysis

My questions were developed from common themes that emerged from the literature review. The themes discussed in the next chapter relate to the above questions thusly:

1. Skill vs. Ability, addressed by questions one and two
2. Teachers and classroom dynamics, addressed by questions three and four
3. Identifying successes and failures, addressed by questions five and six
4. Creative identity, addressed by question seven
5. Creativity in mathematics, addressed by question eight
6. Reflections on gender in mathematics, addressed by question nine

Conclusion

Through remote qualitative interviews and questionnaires, I will address the research question: *What is the relationship between mathematics achievement and self-concept of gifted female high school seniors?* Chapter four will explore each theme by presenting participants' voices, followed by connections with and contradictions of the literature presented in chapter two.

CHAPTER FOUR

Results

Participant	School Location, Type, and Size	GPA	Test Scores	Highest Math Course Completed
Laura	Sioux Falls Public 2,000	3.8	ACT Math: 29 Composite: 32	AP statistics
Jessica	Belle Fourche Public 350	4.17	ACT Math: 30 Composite: 28	AP calculus/college algebra
Erin	Aberdeen Public 1,200	3.96	ACT Math: 25 Composite: 33	Advanced math (trigonometry)
Marissa	Vermillion Home Schooled	3.7	GED Math: 58^{th} percentile Other subsets: 97-99^{th} percentile	Precalculus
Ashley	Rapid City Private Catholic 350	Information not provided		

This chapter will connect the stories of the above participants to the themes identified in chapter two and the questions outlined in chapter three. Each of the following six themes will connect participants' voices and experiences to the body of literature:

1. Skill versus ability
2. Teacher and classroom dynamics

3. Feelings of success and failure
4. Creative identity
5. Creativity in math
6. Gender in math

The chapter will conclude with participants' final thoughts and a review of existing research and literature. The data in this chapter will lead to conclusions and suggestions for further study in chapter five.

Skill Versus Ability

When participants self-assessed their skills, abilities, and enjoyment of math, a pattern in the data naturally divided them into two groups according to ability. Laura and Jessica described themselves as good at math. Laura identified her logical thinking skills and her ability to grasp math concepts faster than most of her peers as measures of her skill and ability. She provided a caveat, however, saying, "Despite this skill, math is not my favorite subject. I am good at math, but I do not like it" (personal communication, June 7, 2015). Jessica described herself as "very good at math," elaborating thus, "Out of 10, I'd say I'm probably an eight at math." Her signifiers of math ability were the levels of courses she took (AP calculus and college algebra) and receiving good grades in them. Describing her enjoyment of the subject, Jessica observed, "I like it, but sometimes I over think the problems and end up disliking it." Both Laura and Jessica provided primarily external identifiers for their abilities: For Laura, it was her speed of understanding relative to peers; for Jessica, it was grades. Neither offered much elaboration on their enjoyment of the subject.

Marissa, Ashley, and Erin, who did not enjoy the subject and did not describe high skill levels, offered much more nuanced, elaborate, and lengthy responses. Both Marissa and Erin cited average or slightly above average test scores as indicators of their ability level; comparing their scores in math and over all on the GED and ACT, described earlier, each felt the disparity between math and other subjects evinced their struggle with math. Whereas Laura had cited her quick understanding, Marissa, Ashley, and Erin each mentioned feeling inadequate when they did not readily understand math. Marissa explained, "A C+/B- in math to me was basically failing. I told myself I was bad at it, that I didn't understand, and it came through in my work. Math has never come easily to me and that gives me crippling anxiety." Ashley observed,

> I enjoy math only when I fully understand the material. For instance, I didn't have a very good teacher for my algebra II, trigonometry, and pre-calculus classes. I ended up disliking the classes because I was often frustrated with the material. It wasn't coming easy to me. I received passing scores, however, and I was eligible for AP calculus.

And Erin concluded that her math skills were just barely above average, "…based on my math ACT score, struggles in classes pertaining to math (though I did take honors courses with the lowest score being a B+), and general feeling of inability compared to students who take similar classes to me." In Marissa's case, average math grades were jarring, since they were not in line with her grades and achievement levels in other classes. Ashley and Erin, however, were in advanced and honors classes and did well enough to qualify for the most rigorous mathematics class and earn high marks, respectively. Erin, at least, seemed to recognize that she did well enough academically, but neither she nor Ashley considered their work and outcomes to be successes.

Each participant offered unique insights and opinions about the relationship for enjoyment and skill in mathematics. Laura and Jessica, who both identified as strong math students, offered distinct factors affecting their enjoyment of math. Laura's mathematical ability had no bearing on her enjoyment of the subject. She noted,

> Because I do understand math at a very high rate, this should mean that I enjoy it, and that's not the case. I think for myself, the enjoyment in a particular class comes more from my classroom experience (teacher, classmates, environment) rather than the curriculum itself. Math tends to be a little "dry".

Jessica, however, countered, "I would say enjoyment determines my skill or ability to an extent. I have the skills and abilities to complete tasks, but my success is more determined by how much I enjoy the activity I am doing." Laura did not enjoy the tasks or content in math classes but took pleasure in the social dynamics. Jessica felt more successful and an inclination to succeed when she enjoyed and was engaged in the learning activity.

Marissa, Ashley, and Erin each believed that skill and ability determined their enjoyment. Erin observed the cyclical, self-perpetuating nature of ability and enjoyment:

> While my ability made me dislike math initially, because I began disliking it I didn't enjoy or spend as much time on math homework as I probably should. My level of like was determined by my ability and then my level of like determined how much I worked to improve that ability essentially.

Marissa echoed this notion, saying, “Assuming I'd fail, I did not try as hard, thus leading to a lower-level skill set.” Both she and Ashley juxtaposed their love of learning and enjoyment of other subjects with their feelings about math. Marissa explained, “I love learning. I actively enjoy literature, social studies, the arts, science, etc. I'm good at all those things. I've always been frustrated by math. It never came naturally to me. My frustration made me feel like a failure and completely depleted what enjoyment I once had for the subject.” Ashley asserted,

> I'm not a science and math oriented thinker. I've always been wired more towards literature and language than lithium and logarithms. However, I enjoy learning, and I pride myself in my ability to grin and bear classes I don't really like in order to keep a high GPA. I work hard in all my classes whether I like material or not. If I start to enjoy a class I wouldn't normally like because I'm really understanding the material, it's just an added bonus in my mind.

Here, Ashley hit on the confusing relationship between achievement, ability, and identity. She recognized her ability in and affinity for other subjects, drawing a line in the sand between the humanities and STEM domains, planting her feet firmly on the side of the former. At the same time, she acknowledged that she could play the game and get the grades she desired and expected. The times Ashley enjoyed deeper understanding remained isolated incidents; she did not come to expect success or enjoyment in math.

The participants offered many insights into the relationship among skill, ability, and enjoyment. Participants demonstrated blended focus on performance and mastery learning (Heilbronner, 2011). Participants who did not have positive feelings about math disidentified and sometimes disengaged from it (Lesko & Corpus, 2006). Their enjoyment influenced both their intrinsic motivation in math (Abu-Hamour & Al-Hmouz, 2013) and their desire to improve (Fogliati & Bussey, 2013).

Teachers and Classroom Dynamics

Participants' descriptions of favorite and least favorite math classes incorporated both understanding and social dynamics. Positive connections with peers and teachers were a key component of favorite classes.

Laura: I find those classes in which I enjoyed myself and was surrounded with positivity to be the ones that I enjoyed but also the ones that I learned the most in.

Jessica: I like simple/intermediate algebra because I like systems of equations and I like geometry. I dislike calculus because the problems are so massive that one little mistake makes the whole thing wrong and you have to start over.

Marissa: In seventh grade, … I didn't have any friends in my pre-algebra class. I sat by one girl I vaguely knew, but everyone was so buddy-buddy, and I didn't have anyone like that. It made me dread math every day. In eighth grade, all my best friends were in my math class. It was amazing. We had a table together and helped each other out. That's the last time I felt I excelled at math; when I had a solid support group literally sitting around me and something to look forward.

Erin: My favorite math class was probably honors geometry. Mostly I enjoyed this class because I had it during a very motivated time in my life and the concepts came relatively easily to me because they weren't as dependent on a formula. My proofs often ended up being quite different from the majority of the class but usually ended up being correct. My teacher was also a goofball old man who I thoroughly enjoyed. My least favorite class was honors algebra II because it was hard, and I cried a lot. … I didn't enjoy it and thus didn't spend a lot of time on it. Also my teacher wasn't the most pleasant and seemed to be quite full of himself proclaiming multiple times that he was a math "wizard".

As the following data demonstrates, the participants valued teachers who fostered positive relationships and whose efforts extended beyond math content instruction. Each young woman shared her experiences:

Laura: The teachers that were my favorite were the ones that taught me beyond the math curriculum; the ones that did not let mathematics be the limit for the syllabus. Those teachers who were my favorite created a dynamic classroom that kept up energy and promoted positivity. Those teachers who only taught within the bounds of the required material and did not work to create a learning environment that promoted positivity tend to be at the bottom of my "favorite teacher list".

Jessica: My favorite teacher was not only knowledgeable about the material he taught, but he also connected and built relationships with his students. My least favorite teacher was knowledgeable, but could not care less about getting to know his students. He just handed out packets and made us figure it out on our own. My favorite teacher helped us learn by making it interactive and fun.

Marissa: My favorite, favorite math teacher was Mrs. Johnson. She was amazing. By far the best teacher I've ever had. She took the time to get to know students and tended to each of our personal needs. When I failed, it felt like an opportunity for progress. My least favorite math teacher was Mr. Moore. He was a snobby old white dude who enjoyed people who immediately understood everything. Of course, no one did. He had a line out of his classroom every study hall because he never taught us well enough in class.

Erin: My favorite math teacher was my honors geometry teacher. He was very quirky, encouraged outside of the box thinking, and was just generally an agreeable person. He was filled with many personal stories and came off as incredibly intelligent without ever feeling like he was trying to come off that way. My honors algebra II teacher on the other hand was quite the opposite. He came off as incredibly full of himself and didn't allow for much creativity in answers. He frequently stressed that his way was the only way to get to an answer and that the answer didn't matter, but even if all work was correct aside from the answer (stupid mistakes like forgetting a negative or adding wrong happen) he still took off all of the credit for the answer. This type of contradictory behavior seemed to imbue his entire teaching style and it was off-putting to me. He even liked me, but I still didn't enjoy his ideology in regards to the classroom.

Several factors distinguished positive and negative teacher and classroom dynamics: Participants valued teachers who engaged students in a variety of ways (Landis & Reschly, 2013). They benefited from positive relationships with teachers and peers (Rinn et al., 2011). Participants took more intellectual risks in supportive environments (McMaster & Betts, 2007). Classes with gifted peers sometimes strengthened participants' estimation of their skills and abilities, but not always. This was somewhat contradictory to the findings of Preckel and Brüll (2008).

Identifying Successes and Failures

Laura's Experiences. Laura's feelings of failure stemmed from experiences that were discordant with her self-perception. She describes her earliest negative experience thusly:

> My first memory of failure in math was in fifth grade when I failed a unit in math. Being a gifted student, this was very hard for me, and even harder that I needed more help. I remember following that, having an understanding that if I didn't understand, it was essential to ask for help. It was a very humbling, … necessary … experience. It was the moment that took me down a couple notches in my education and caused me to push myself to be better.

From that experience, she learned to recognize her limits and move beyond them. Her most recent feeling of failure came from her not meeting her expectations of herself:

> My most recent failure came in my AP Statistics course this past year when I scored poorly on one of our exams. [It] was not because I got a poor score, [but] because I knew I did not try my hardest [and] because I felt like I did not do my best to learn and understand the curriculum.

Laura generalized her first feeling of success:

> I think my first memory of success probably occurred on any cumulative exam I took where, [when] presented with a large variety of math concepts, [I] was able to make my way through every question with ease. I felt that my entirety of math

> education was used and that I was able to solve all the problems. My determinant of success is largely … the grade I receive in the particular course, … if the curriculum and learning is long standing in my mind, … [and if] I am able to walk away from the class with more knowledge and understanding than when I entered.

Her most recent feeling of success was a specific example of her efforts: "My most recent feeling success in math came following the completion of my AP Statistics exam. I felt so positive because I left the exam feeling great. I knew that I may not have answered every question perfectly, but I felt that I had answered each question as best as I could. It was a very positive feeling, and I felt like my hard work throughout the year had paid off."

Jessica's Experiences. Jessica's feelings of failure mirrored Laura's. She explained, "My earliest feeling of failure was in high school. It happened when I did not do very well on a test because I didn't study. I had never had to study for math before. I thought it was easy. I felt like a failure because I knew I could have done better." Her most recent feeling of failure was in opposition to her extremely high standards for her success: "My most recent failure was when I missed only three points in my college algebra test. I made a few easy mistakes on a test, and I missed those only points all semester. I knew I did well but I could have done better."

Jessica's measured her success by external factors. Initially, she recalled, "My earliest feeling of success in math was in middle school when I was in my own math group because my skill level was beyond the skill levels of my peers. I knew I was successful when I could do their problems but they couldn't do mine." Lately, success also related to her putting in her best efforts, "My most recent success was obtaining a 97 in AP calculus. I felt so smart and I knew that I worked my hardest, and I was rewarded for it."

Marissa's Experiences. Marissa shared an early, detailed feeling of success:

> My earliest feeling of success in math was in the first grade. … A friend asked me for help and I knew the answer. I knew I was successful because I was able to help a friend and that was the best feeling. I remember this not as a personal success, but as a math specific success because even at age six I had struggled with math. Not viciously, but I knew it was my worst subject. I vividly remember seeing my ability to answer this question for my friend as a glimmer of hope. I thought, "I must be getting it! Progress!" With almost every other subject, I can look inward, but I feel like I've always looked outward for support in math. It's a team activity, something almost social. When I had a good group of people in my math class, I excelled. When I felt alone and like I was the only one with questions, I did not do so well. This memory of succeeding in math was the first time someone else was looking outward for the answer to a math question and they looked at me. I was their support, I was there to make sure they didn't feel dumb, and together we did well.

Marissa's feeling of failure had real, financial consequences:

> My first feeling of true failure in math was very recently. I was taking a placement test for university and placed in MATH 095. You have to pay for 095 and it takes a whole semester, but there's no credit for it. I felt like trash. I literally don't have enough money to go to school and now I have to take this credit-less

> course because I'm terrible at math. I hate to even think about it. I feel like a failure because I'm wasting time and money. If I were good at math, if I were good at anything, this wouldn't be a problem. I feel like a complete disappointment. I feel like I'm suffering deserved consequences for being so bad at math all these years.

She noted, “I never considered myself a complete failure in math until recently, so my most recent failure and my earliest failure are the same thing. Previously, I always saw hope and room for improvement. This time, with the college placement exam, I felt neither of those.”

After repeated and pervasive feelings of failure, success became elusive more recently: “I honestly do not remember a recent feeling of success in math. I'm trying to think back through all my math courses, but I think when I was succeeding all I saw it as was finally doing what I was supposed to be doing. I always dwelled on my failures in math, but any successes I had seem to have been completely overshadowed.”

Erin’s Experiences. Erin described her earliest feeling of failure in math thusly: “Getting caught ‘cheating’ (counting on my fingers) in a test in second grade felt pretty gross. I was unable to do the addition problems in my head so my teacher took away my test and told me I was the first person to have cheated that she'd ever had. I felt incredibly guilty.” Most recently, she said,

> My math ACT score felt pretty much like a failure. It was lower than my next lowest subscore by nine points and I felt pretty inadequate in that area in

> comparison to the rest of the test. Worst of all, I had retaken the ACT merely to improve my math score and it's the only score of mine that didn't improve at all.

She was more reticent in discussing feelings of success in math. After offering the disclaimer, "Honestly I don't frequently feel successful in math," she went on to describe her earliest feeling of success, saying, "I did however experience a feeling of some success in honors geometry when my teacher initially considered my answer incorrect then stared at the board for a while before saying that actually the way I did it was more straight forward than the way he'd been doing the proof for most of his life. That was pretty cool, but other than that I frequently feel unsuccessful in math." More recently, she explained,

> I got an A on my advanced math final despite having been absent for much of the class due to speech activities. I knew I was successful because it got me the highest grade I could get in the class. Success felt pretty good, mostly because I knew I wouldn't have to take another high school math class after that one.

Even her most recent feeling of success was tainted by her relationship with the subject.

Conclusion. The data reveals that participants' feelings of success and failure extended beyond grades and test scores. Participants' self-criticism, self-concept, and feelings of success and failure related to their standards for themselves (Tippey & Burnham, 2009). Some experiences, like Erin's, intrinsic motivation in math (Abu-Hamour & Al-Hmouz, 2013). All participants demonstrated persistence and desire to improve, however, which contradicts prior findings by Fogliati and Bussey (2013). The motivation to improve was most evident in testing, especially the ACT and GED. While their focus was performance and perhaps not mastery, Erin and Marissa persisted. Their frustration and feelings of failure were the result of persistence not yielding improved scores. These experiences contradict Heilbronner's (2011) discussion of performance versus mastery learning.

Creativity

Creative Identity. Each participant asserted her creative identity and enumerated interests and passions. Laura said, "I consider myself to be a very creative person. But I am also a very busy person. … [In] moments when I have no other thing to do, I resort to creative outlets, whether … music, art, or even literature." Jessica considered creativity to be release and relief: "I am creative because I enjoy writing. I write poetry as an outlet when I am stressed or I have something weighing on my mind." Marissa revered the creative process:

> I love to write, sing, dance, and think up new ideas. I feel at my strongest when creating, or exploring the world of creativity. I think I am drawn into creating … by the simplicity of it all. You may be creating something complex, but the rawness of creativity is basic and pure.

And Erin found particular areas of interest and focus in "…fashion, political science/government type work, and writing…," elaborating, "I just really enjoy all of these avenues of expression so it is easier for me to be able to spend a lot of time thinking about them, thus generating somewhat unique ideas in regards to how I view and interpret various aspects of them."

These aspects of participants' identity and self-concept could potentially counteract negative impacts of stereotype threat (Gresky et al., 2005). Participants' creative outlets can engage them in different ways (Landis & Reschly, 2013). They valued opportunities to express themselves (Gadanidis et al., 2011).

Creativity in Mathematics. Participants recounted few opportunities for creativity in their math classes. Jessica said, "Last year, we had the opportunity to make our own practice tests. It was really nice because we knew what we needed help with, so we got to make sure we studied certain things." Erin noted, "Honors geometry was one of the few classes I've had in which I felt like there was a way other than just the teacher's recommended route that could achieve a correct answer." Laura stated simply, "Unfortunately I can't really recall any moment in my math experience where I was able to utilize [my] creativity." Marissa offered her thinking about creativity and math:

> As I've been answering these questions, I realize my relationship with math is very personal and complex. Since what I love about creativity is the simplicity, you'd almost think I'd love math. Everything is math. Math is like the most basic building block of life. Though it is so complex, it's really the most simplistic thing we have. Despite this, I don't have many memories of creativity in math. I know when I was young we would draw pictures to go with our story problems. I've used blocks, crackers, marbles, and various other things to help solve math problems. Those are actually perhaps some of my favorite math memories. When creativity was used to place math in front of me visually, so I could learn by seeing/doing.

Marissa's experiences of creativity in math were positive but limited to her early learning.

The data shows that participants have had limited opportunities for creativity in mathematics (Coxbill et al., 2013). Participants expressed the desire for opportunities of personal expression and project-based learning (Gadanidis et al., 2011). Such opportunities may enhance their motivation, curiosity, and transfer of skills (Lemons, 2011; Matsko & Thomas, 2014).

Reflections on Gender in Mathematics

All but one of the participants mentioned the longstanding stereotype that males are better at math and/or that females are not good at math (Aronson, 1995). Only Jessica felt her gender was advantageous, saying, "I think my gender is an asset to me in my math classes because I am given more responsibilities, like helping to correct tests and helping others study. I am given more freedom because my teachers know I am capable of getting my work done if something comes up." Perhaps for her, a feeling of pride and trust came from these increased responsibilities. While Jessica equated increased responsibilities with her gender, her individual performance and work habits account for them. She did not identify a direct relationship between her gender and her experience with the subject and learning of mathematics.

For each of the other participants, distinct experiences shaped their perceptions of gender liability in mathematics. Laura felt that girls suffer the consequences of lower expectations:

> Typically in math classes it is always the “boys” that score the best. If anything there is not enough pressure for girls in math classes; no one expects you to do as well as them. I find it extremely rewarding when the ones who perform the best in the class are girls.

Marissa felt that teachers, particularly male teachers, prioritized male students’ learning:

> My gender has almost always been a liability to me in math classes. Math is a male-dominated field and so most of my math teachers have been men. When I had questions or concerns, it was made known they were less important than those of my male classmates. The basic rules of sexism always came through in my math classes more so than anywhere else in school, I think.

And Erin related an amalgam of messages and experiences that impacted her learning:

> Frequently being female feels like a liability in math classes. Despite being one of the more academically oriented people in my class, I would compare myself most frequently to males in science and math dominated courses. It probably also doesn't help that I've been told countless time from a young age that women are bad at math and science. Being female itself doesn't ever feel like an explicit liability, but the socialization surrounding my gender does. In AP chemistry (though not a math class, it is heavily rooted in mathematics) I heard many jokes geared toward females' inability to do math/science by the boys in the row behind me and this stigma made participating in the class more difficult.

Participants’ experiences reaffirm that female students encounter limited environments that empower female students as learners and contributors safe and positive learning environments, in which female students feel respected and valued as thinkers and contributors to their community of learners, are limited (Rudasill, et al. 2009). They also exemplified how stereotype threat can stem from internal fear or external expectations, whether they believe in the stereotype or not (Shapiro & Williams, 2011). It is possible, if not probable, that participants' math self-concept and performance expectations have differed from male peers' for several years (Skaalvik & Skaalvik, 2004).

<u>Participant's Final Thoughts</u>

At the end of the questionnaire, participants were free to share any remaining or culminating thoughts. Laura and Marissa took the opportunity. Laura volunteered a broad observation:

> I truly think that in the course of mathematic there is not enough emphasis on creativity. There is not enough work done to engage students in different ways. I also feel that in mathematics boys have the gender superiority. And girls are often regarded as less than. I think this is very typical in any STEM field of study.

Offering a deeply personal reflection, Marissa said,

> From answering these questions, I found that I focus far more on my failures in math than on my, perhaps limited, successes. My relationship with math is excessively complex, as is any relationship. I feel like I've never had the proper continuous support system that I personally need to succeed in math. Maybe if I find it, after or during 095, I'll finally bridge the gap and be less terrified of math.

Their thoughts provide glimpses into the spectrum of experiences gifted female students have in math education. These young women, who have experienced dichotomous levels of success and achievement in mathematics, mention deficits in creativity, engagement, and support. Concerted efforts to address these deficits could empower female students both individually and collectively in their math education and self-efficacy.

These young women have offered powerful insights into the experience of gifted female students in mathematics. Their reflections on their feelings of success and failure, relationships with teachers, creative identity and opportunities for creativity in mathematics, and gender identity and liability within mathematics begin to unearth the nuanced, numerous components of achievement and self-concept. The more opportunities participants had to express themselves and take ownership of their learning, the better they felt and performed. Participants most valued teachers who developed positive relationships with them, supported them, and valued their thinking and abilities.

Conclusion

The data herein have shown that the relationship between mathematics achievement and self-concept of gifted female high school students is multidirectional and multifaceted. To build female students' investment in mathematics, educators must invest in them. Female students' thinking and problem solving approaches can and need to contribute to the field and advancement of mathematics. Kindergarten-12 educators must foster female students' passion and creativity in mathematics if young women are to pursue higher education in the field.

This study has yielded new perspectives on the experiences of gifted female high school students in mathematics. It has the potential to spark further discussion and research in the fields of education, mathematics, and gender studies, among others. The next chapter will examine the limitations and implications of the study, as well as opportunities for future research.

CHAPTER FIVE

Conclusion

Through examination of the current body of literature and new research, I have sought to answer the question: *What is the relationship between mathematics achievement to self-concept of gifted female high school seniors?* The data have not yielded a definitive answer, if such a thing exists; however, they have elucidated the nuances and complexities of self-concept and mathematics achievement.

Literature Summary

The existing body of literature revealed many themes. Key topics included definitions and stereotypes of giftedness, gender difference in math/STEM, malleable versus fixed intelligence and ability in math, self-concept, and stereotype threat.

Definitions and stereotypes of giftedness evinced how elusive and challenging the label can be. Teacher observations and recommendations are integral to students' enrollment in gifted programs, but many teachers operate under common, often untrue stereotypes of giftedness (Carman, 2011). Gifted students can be extremely self-critical and see their failure to measure up to an ideal of giftedness (Tippey & Burnham, 2009). As a result, gifted students may try to maintain low visibility in educational settings (Coleman & Cross, 2014).

Gender differences in math/STEM proved to be numerous. Gender differences and gender typing highlight perceived discrepancies in the abilities and interests of male and female students; the ubiquitous acceptance of these differences has been foundational to stereotype threat. Gender differences emerged in an experiment around problem solving: male students focused on restoring national glory, while female students focused on progress and improvement (Malin & Makel, 2012). Gender differences also emerged in intrinsic motivation in math (Abu-Hamour & Al-Hmouz, 2013). Finally, gender differences may warrant a greater, more inclusive variety of exercises and measures of spatial ability (Coxon, 2012).

The literature examining malleable versus fixed intelligence and ability prefaced the amalgam of factors influencing engagement in mathematics. Passion for learning mathematics developed from motivation and persistence, which allowed for risk taking and exploration of creative and mathematical possibilities (Coleman & Guo, 2013).

Creative passion can be an intrinsic motivator and can be a valuable motivation tool in math (Lemons, 2011). Opportunities to be creative in math can enhance curiosity, metacognition, and transfer of skills (Matsko & Thomas, 2014). Mathematically creative students, distinguished by Kruteskii's (1976) nine ways of thinking, demonstrate innovation and reusability of their manipulation of math principles, but traditional and teacher-centered instruction rarely affords students to demonstrate unique thinking (Coxbill et al., 2013). As a result, even gifted students who do well in math often do not identify it as their favorite subject; they prefer subjects that foster personal expression and project-based learning (Gadanidis, et al., 2011).

For those reasons, creativity can engage students, whose positive attitudes about math drop dramatically between elementary and middle school (U.S. Department of Education, 2003). Types of engagement include academic, behavioral, affective, and cognitive (Landis & Reschly, 2013). Messiness, or productive confusion, is difficult for performance learners, who fear failure; mastery learners are more likely to persist (Heilbronner, 2011). A supportive, creative environment not only allows for but also embraces messiness (McMaster & Betts, 2007).

Research of self-concept has revealed how an individual's perception of herself could be shaped by external influences and supports. Social and educational support from a variety of people, including parents, teachers, and peers, in and out of school contribute greatly to self-concept (Rinn, Reynolds, & McQueen, 2011). Female gifted students tend to underestimate themselves and their abilities, especially when surrounded by or grouped with gifted peers (Preckel & Brüll, 2008). Attempts to foster empowering environments for female students are limited (Rudasill, et al., 2009). Gender differences in math self-concept and performance expectations emerge in elementary school and continue into adulthood (Skaalvik & Skaalvik, 2004).

Finally, research of stereotype threat has proven its impact on individuals' self-efficacy. Stereotype threat can come from internal fear or external expectations that the stereotype is true (Aronson, 1995). An individual need not believe the negative stereotype to be subject to the threat of it (Shapiro & Williams, 2011). Female-mathematics stereotype can undermine performance and desire to improve skills (Fogliati & Bussey, 2013). Individuals can take ego-protective measures including disidentification, disengagement, and self-handicapping (Lesko & Corpus, 2006). Recognizing and reflecting on numerous aspects of her interests, abilities, character, and life can counteract the negative impact of stereotype threat (Gresky et al., 2005).

Limitations

This study had several limitations in terms of methods and participants. The variety of insights and perspectives participants shared highlighted the more abstract, nebulous aspects of engagement, creativity, giftedness, and achievement. The depth and breadth of responses from participants were limited, however, because the questionnaire was static. In-person interviews may enhance understanding and interpretation of participants' experiences and beliefs. The interpersonal dynamic of interviews may have led to new ideas and spontaneous extension questions. From the questionnaire responses, themes emerged that warrant further exploration with participants. More time and discussion may lead to new lines of thinking. Extending the qualitative method of the study may also further understanding of participants' self-concepts. Throughout the research questionnaire, participants were asked to share feelings and experiences of success and failure. Supplementing those questions with prompts to provide explicit, personal, working definitions of achievement, success, and failure could present a valuable framework for participants' experiences and self-concepts.

I was grateful to work with a group of participants I knew. They are impressive, capable, articulate, thoughtful young women. The small number of participants allowed me to focus on each subject's narrative, but I would love to know if the themes that emerged in the stories of these four would pervade the stories of gifted female students from even more diverse racial, socioeconomic, geographic, and educational backgrounds. I can speculate that the patterns I noticed would extend beyond this sample, but I cannot be certain.

I appreciated working with subjects who had completed their K-12 education, because they had the greatest range of courses and experiences to draw on. The questions I posed, however, could provide valuable insights into self-concept of gifted female students of other ages as well. The experiences and perceptions of success and failure could be especially potent in grades 6-10, when students are encountering algebra and geometry, which bridge the gap between early and higher learning in math. Those years would also offer insight because social interactions can be especially important to students in their early teens.

This study lacked a rigorous, definitive measure of ability or giftedness to determine the sample. As I said, each participant is highly capable, demonstrating motivation and ability to perform well in school, as evinced by her GPA and ACT scores. I do not know how a stringent set of parameters would affect the body of participants or their responses, but it is a limit worth noting: After all, a gifted female student who had spent her secondary school career at an academically selective high school like the one in the study by Abu-Hamour and Al-Hmouz (2013), may offer different insights and experiences to her peer in a small, rural school in South Dakota. Or thematic similarities could transcend learning environments. Interactions with and perceptions of teachers would be especially interesting to compare. Intentionally studying participants from different educational settings, including rural, urban, and suburban public, private, charter, magnet, single-sex, and academically selective schools, could provide insight into the role of learning environment in participants' achievement and self-concept. Investigation of learning environment could break down further by size and gender composition of classes, as well as gender of teachers.

Implications and Recommendations for Future Research

The reflections and insights of my research participants present many avenues to explore interventions for future research of self-concept achievement among gifted female high school students. Experiments around conditions like teaching style, teacher gender, classroom environment, classroom dynamics, and instructional methods could test hypotheses to change – and ideally improve – both math achievement and self-concept of gifted female high school students. These outcomes, in addition to the qualitative research I have presented here, may interest parents, teachers, and students in high school. They would likely also interest stakeholders in higher education and STEM fields, who hope to draw and keep more female students and professionals in those areas.

Publication of this research could have several implications for mathematics education. It could serve as a reminder to teachers of the value of humanizing the mathematics classroom through relationship building. It could prompt teachers to implement more messiness, creativity, and risk taking in mathematics lessons and model those qualities for students. It could reinvigorate gifted education and examination of the needs and challenges of gifted students. This research could disrupt the status quo and engage, motivate, and inspire female students. It could help female students to find and their voice and embrace their thought processes in mathematics. If this research can spark a discussion in K-12 education, it could lead more female students to pursue higher education and professions in the field of mathematics. A greater representation of females in mathematics could change both the theory and the practice of mathematics and its pedagogy.

Conclusion

Gifted students face academic, social, and personal challenges. Female students face additional challenges of gender typing and stereotype threat. The four young women participating in this research reflected on their learning experiences, interactions with teachers, feelings of success and failure, and creative outlets and opportunities. Participants' experiences with success, failure, and teachers impacted their self-concept, self-efficacy, and achievement in mathematics. Teachers who valued participants' work, creativity, and problem solving help these young women find their voices as thinkers, learners, and mathematicians. When participants felt respected, trusted, and autonomous, they enjoyed their learning and experienced success. Mathematics education needs more explicit development of these factors to develop the diversity and strength of ideas that female students contribute.

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