

**MATH TALENT DEVELOPMENT OF ELEMENTARY SCHOOL STUDENTS:  
THE RELATIONSHIP OF GENDER, MATH MOTIVATION,  
AND GOAL ORIENTATION TO MATH ACHIEVEMENT**

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**A Dissertation**

**Presented to**

**The Faculty of the School of Education**

**The College of William and Mary in Virginia**

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**In Partial Fulfillment**

**Of the Requirements for the Degree**

**Doctor of Education**

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**by**

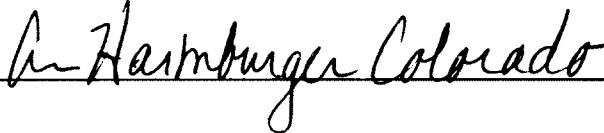
**Ann Haimburger Colorado**

**October 2014**

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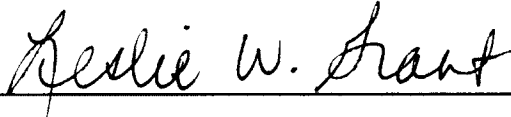
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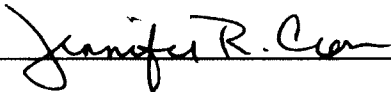
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## DEDICATION

I dedicate my dissertation to my family and friends for their love and support during my entire 6.5 year program. I would not have made it if it weren't for all of your pep talks, dinners, glasses of wine, babysitting, and encouragement. You all kept me sane! Thank you to Ann, Rudy, and Rudy; Letty and Mike; Laura; Ashley; Brittany; Anna; Liz; and Britta. My deepest appreciation goes to Griffin, Garrick, Julian, and Alek—the loves of my life. You all hung in there with me! Thank you for all of your sacrifices while I pursued my dream of completing my doctorate.

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## ACKNOWLEDGEMENTS

I would like to thank my dissertation committee for their endless, positive support during my writing process—from conception of my idea through the final edits. Dr. Tracy Cross motivated me by his belief that my work will be a valuable contribution to our field of gifted education. Dr. Leslie Grant was a positive role model for me throughout my coursework and writing. I especially thank Dr. Jennifer Cross for the hours she spent editing each draft of each chapter and her refresher lessons on the nuances of writing such as: the use of the em dash, the use of *since* versus *because*, and the many synonyms to use in place of the verb “showed.”

I also wish to express gratitude to my writing partner, Laura Burton, Ed.D. Candidate. Thank you for answering my Facebook message last winter! I probably wouldn't be finished writing if it weren't for you holding me accountable. I will always recall our writing (and gabbing) sessions at Swem with fondness.

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**ABSTRACT**

Research has established that motivation is an important factor of student achievement. Many researchers in the field of gifted education consider motivation to be a crucial component of giftedness, yet the literature base for motivation and math talent development within gifted populations is scarce. This descriptive study used a within-group design to measure the math motivation, math achievement, and goal orientation of high-ability 5<sup>th</sup> grade math students to elucidate the relationships among motivation, achievement, goal orientation, and gender. Findings indicated that math achievement, math motivation, and goal orientation were similar for both genders; students had high math achievement yet low math motivation; and a high number of students had a performance goal orientation. Ideas for future math motivation research for the gifted are shared.

*Keywords:* gifted math students, math achievement, math motivation, goal orientation

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## **Chapter 1**

### **Introduction**

The United States has traditionally been a world leader in innovation in the fields of science, technology, engineering, and math (STEM). Currently, however, the U.S. is at risk of losing its competitive edge due to students who are unprepared to enter STEM majors in college (U.S. Department of Education, n.d.). Math is an area of particular concern. U.S. students have lower math achievement scores than several other education systems in countries all across the world. According to the 2011 Trends in International Mathematics and Science Study (TIMSS), 4<sup>th</sup> grade students in the U.S. scored lower than 8 other education systems around the world and 8<sup>th</sup> grade students scored lower than 11 other education systems (“education systems” refer to either a country as a whole or to a part of a country, such as a state or province; Provasnik, Kastberg, Ferraro, Lemanski, Roey, & Jenkins, 2012). Results from the 2012 Program for International Student Assessment (PISA) indicate that only 9% of 15-year-old students in the U.S. perform at the highest proficiency levels in math, lower than 27 other education systems around the world. Further, 26% of U.S. 15-year-olds perform at the lowest proficiency level in math (Kelly, Xie, Nord, Jenkins, Chan, & Kastberg, 2013). Besides the low math performance of American students, our country also has low numbers of females pursuing STEM coursework, majors, and fields of employment. The U.S. Department of Education’s Office of Civil Rights reports several dismal statistics regarding females and math/STEM education:

- Although girls and boys are equally represented in high school math courses such as Geometry, Algebra 2, and Calculus, boys far outnumber girls in Advanced Placement courses in Calculus and Statistics;
- Boys pass AP tests, in general, at higher rates than girls (60% versus 55%);
- Girls make up only 21% of the members in STEM programs at the secondary level and 24% at the postsecondary level;
- In 2008-2009, only 31% of STEM degrees and certificates were awarded to women (U.S. Department of Education, 2012).

In addition, a recent Girl Scout Institute research study shows that only 31% of surveyed Girl Scouts who expressed an interest in STEM said they were interested in a career in mathematics (Modi, Schoenberg, & Salmond, 2012). U.S. President Barack Obama, in a Google+ Hangouts interview, shared his observation about girls and STEM:

One of the things that I really strongly believe in is that we need to have more girls interested in math, science, and engineering. We've got half the population that is way underrepresented in those fields and that means that we've got a whole bunch of talent that... is not being encouraged... (The White House, 2013)

In light of low levels of math performance of American students in comparison to students from around the world, and many groups of students (such as females) having low representation in STEM coursework and fields, President Barack Obama has deemed STEM education a priority for the country. Through the "America COMPETES Reauthorization Act of 2010," the Committee on Science, Technology, Engineering, and Math Education (CoSTEM) was tasked with inventorying and reorganizing federal

STEM initiatives and activities. Its goal is to enhance STEM education in the United States in five areas:

1. improve instruction in preschool through 12<sup>th</sup> grade,
2. increase and sustain public and youth engagement with STEM,
3. heighten the experience of STEM undergraduate students,
4. better serve groups historically underrepresented in STEM fields (such as Hispanics, African Americans, first-generation Americans, people with disabilities, and women), and
5. design graduate education for tomorrow's STEM workforce (U.S. Department of Education, n.d).

The time is politically ripe for improving STEM education in the United States, but how do we increase the number of students for— and keep them in— the pathway (also called the “STEM pipeline”) of courses that will prepare them for advanced math coursework, majors, and careers? According to a recent National Science Board report, “Our Nation’s success in developing future STEM innovators rests squarely on the capacity of our education system to identify and nurture ability,” (National Science Board, 2010, p. 18). Once schools find students with math talent and place them in appropriately challenging math courses, the problem shifts to keeping students in the math pipeline. High-ability math students at the elementary level— the students who are truly at the beginning of this math talent development trajectory— often respond to the challenging math courses in the following ways: they either demonstrate high math achievement or they do not, and they either drop out of these challenging classes or choose to persevere in them. What causes these differences? Could the reasons be due to gender? Could they

be psychologically based? Or, is there interplay of both of these factors? The cognitive construct of motivation might play a role in high-ability math students' achievement in gifted math classes (Preckel, Goetz, Pekrun, & Kleine, 2008; Vlahovic-Stetic, Vidovic, & Arambasic, 1999). There is a movement in the field of gifted education to include the variable of motivation as a part of the conception of giftedness under the currently proposed talent development mega-model, which views motivation as a necessary component of outstanding achievement in a talent domain (Subotnik, Olszewski-Kubilius, & Worrell, 2011). A deeper knowledge of motivation in young, high-ability math students could help educators increase the identification of math talent at young ages, and could also be a key factor in understanding the math achievement and retention issues of boys and girls who have exceptional math talent.

### **Purpose**

A key strategy of the talent development mega-model is the early identification of gifted potential (Subotnik et al, 2011). However, sometimes students who are selected for gifted or advanced math programs at the elementary school level do not achieve in them and even drop out of them. It is possible that motivation plays a role in some of these students' lack of success in gifted math programs, and motivation is a factor that educators can impact. The model identifies motivation as a critical variable in whether or not a student with gifted potential will attain high levels of achievement. Therefore, the authors of the model call for future inquiry into motivation and giftedness because they—and several other researchers (Bloom, 1985; Cross & Coleman, 2005; Renzulli, 2005, 2012; Sternberg, 1991, 2005) — consider the psychosocial factor of motivation to be an integral part of giftedness. The call is also appropriate because there is a dearth of

research in the field of gifted education on the motivational patterns of gifted/high-ability students in relation to math talent development. In addition, most of the research previously done on general motivation and gifted students has not studied within-group differences (Clinkenbeard, 2012; Dai, Moon & Feldhusen, 1998). Thus, the purpose of this study was to investigate the variable of motivation in elementary students who have been identified as gifted or potentially gifted in math (these students are referred to as “high-ability” math students throughout the rest of the study) and whose math needs are being served through advanced math coursework. Several research questions will be investigated by this study:

1. What is the math motivation level of high-ability math students?
2. What is the math achievement level of high-ability math students?
3. What is the goal orientation of high-ability math students?
4. To what degree is the math motivation level of high-ability math students related to their math achievement?
5. What is the math achievement level of high-ability math students for each goal orientation?
6. What is the math motivation level of high-ability math students for each goal orientation?

### **Significance of the Study**

Why study the math motivation levels of elementary-aged, high-ability math students? Finding and developing young math talent is only part of the battle to increase the number of students in the U.S. STEM pipeline. The rest of the battle is keeping students— especially girls— in the pipeline, performing at high levels. The answers to

this study's questions can be beneficial in identifying potential motivational issues of high-ability math students for the purposes of early math talent identification and the retention of our brightest math students in advanced-level math classes. For example, math motivation might be a factor that schools could consider in their search for math talent at young ages. In addition, knowing the math motivation level of high-ability math students would help teachers to provide interventions for students with high math potential (according to their math grades and standardized math achievement scores) but low math motivation (according to a motivation survey score). Interventions for low motivation are particularly important for girls who are strong in math but have low math motivation, because girls have been shown to lose interest in math in the 6<sup>th</sup> grade (Blue & Gann, 2008).

Another benefit of the current study is to inform the gifted education field about math motivation concerns based on within-group differences. As previously noted, most research on general motivation and giftedness has focused on between-group differences of gifted and non-gifted populations of students. This study was designed to compare differences in math motivation, math achievement, and goal orientation based on gender within the same high-ability math student population.

A final contribution to the field that this study endeavors to make is to gain knowledge regarding math motivation, in general, and its relationship to math achievement and goal orientation. Much of the research currently in the motivation literature for all populations of students examines motivation as a general construct (often using the terminology *motivation in math*). The current study focused on math motivation as a specific construct and the knowledge gleaned from the findings will hopefully make

a positive impact on the identification and/or retention of high-ability, elementary-level math students in the STEM pipeline.

Overall, this study serves an exploratory role to inform the field of viable lines of motivation research, as well as provide insights into the possible need to develop motivation interventions. Further, the results of the study could be generalized to other school systems that use acceleration as a service model for gifted/high-ability math students in elementary school.

### **Operational Definitions**

*Academic intrinsic motivation:* This construct is defined as "...enjoyment of school learning characterized by an orientation toward mastery; curiosity; persistence; task-endogeny; and the learning of challenging, difficult, and novel tasks" (Gottfried, 1985, p. 632). For the purpose of this study, academic intrinsic motivation will be operationalized as a score on the math subscale of the *Children's Academic Intrinsic Motivation Inventory* (CAIMI; Gottfried, 1986a).

*Math academic intrinsic motivation:* Academic intrinsic motivation in mathematics.

*High-ability math students:* These are students who have either been formally identified as gifted and talented in mathematics or who demonstrate the potential for giftedness in mathematics, both determined by the school division prior to this study. Identification as gifted in math was based on students meeting at least three of the following four criteria: math achievement test scores at the 95<sup>th</sup> percentile or higher, cognitive ability scores of 125 or higher, teacher and parent observation scores of 95 percent or higher, and performance on advanced level mathematical tasks of 90 percent

or higher. Identification as potentially gifted in math was based on a math achievement test score at the 92<sup>nd</sup>—94<sup>th</sup> percentile and a math score at the “Pass Advanced” level (500—600) on a state-mandated, 4<sup>th</sup> grade end-of-course test.

*Math achievement:* The academic performance of students in math. For the purpose of this study, math achievement was operationalized in two ways: as the end-of-semester teacher-assigned grade in an advanced-level math class using a traditional 10-point grading scale out of 100 points total, and as a percentile score on a nationally normed gifted math achievement test, the *Test of Mathematical Abilities for Gifted Students* (TOMAGS; Ryser & Johnsen, 1998).

*Goal Orientation:* According to the goal orientation theory of motivation, there are two types of goals that motivate people. Those who hold a *learning goal* orientation are motivated by the goal of increasing their ability and mastering new things; those who hold a *performance goal* orientation are motivated by the goal of looking smart and not looking dimwitted (Dweck, 1999). In the present study, goal orientation was operationalized as a *Learning Goal Orientation*— a focus on learning math for the enjoyment of learning math and for learning math to improve mastery— and a *Performance Goal Orientation*— a focus on learning math to earn good math grades to appear smart. The data for goal orientation are gleaned from two questions on the math subscale of the CAIMI.

*STEM:* This acronym stands for science, technology, engineering, and math. In this study, it was applied to coursework, programs, majors, or fields related to any of the four disciplines.

*STEM Pipeline:* A basic description of the STEM courses and programs that exist from elementary school through postsecondary education. This coursework, when taken over the span of a student's school career, is considered a pathway (or pipeline) into collegiate level STEM courses and future STEM careers.

### **Organization of the Study**

This descriptive study analyzed the math achievement of high-ability elementary school math students through a psychological lens by studying the construct of math motivation. Chapter 1 presents the introduction, problem statement, purpose and research questions, significance of the study, and operational definitions. Chapter 2 reviews the literature and research that is related to the focus of this study. First, an examination of the definitions of giftedness is given to contrast entity-based and talent-based definitions in order to highlight the factor of motivation that is often included in gifted definitions that embrace talent development. Then, an overview of two general theories of motivation and a construct related to the current study is provided. Next, a discussion of the motivation research related to this study is described in four sections: math motivation and math achievement, giftedness and motivation, giftedness and math motivation, and gender and math motivation. The chapter ends with a description of how the current study contributes to the gifted education literature in regard to the relationship of math achievement, math motivation, goal orientation, and gender. The third chapter discusses the methodology and process of data collection for the study. Chapter 4 provides the results of the data analysis for each research question. The final chapter, Chapter 5, synthesizes the findings, discusses the limitations and implications of the study, makes recommendations for future research, and draws conclusions.

## **Chapter 2**

### **Review of Relevant Literature**

Traditional definitions of giftedness do not consider a student's motivation level; they are based on IQ. These entity-based viewpoints adhere to the identification of a gifted student according to an ability score, label the child as gifted across all academic domains, and once the child is deemed gifted, she is always gifted, no matter how well or how poorly she performs in her gifted program. The relationship between giftedness and high IQ can be linked back to Terman and his studies of individuals with high IQ published in 1925. Further, many schools in the United States currently rely at least partially on an IQ score to identify students who are gifted (Subotnik et al 2011). On the other hand, several researchers have viewed giftedness as a talent development process in specific domains of learning, and have included motivation or a closely related variable as part of their definitions or frameworks (Bloom, 1985; Cross & Coleman, 2005; Renzulli, 2005, 2012; Sternberg, 1991, 2005; Subotnik et al, 2011). The current study explores the relationships between and among math achievement, math motivation, goal orientation, and gender in young, high-ability math students at the beginning of the math talent development process. Therefore, it is important to look at how motivation is connected to giftedness by reviewing several of the talent development definitions of giftedness. Additionally, Chapter 2 provides a review of key concepts related to the study, including two theories of motivation and a construct related to the present investigation as well as research on math motivation and math achievement, giftedness and motivation, giftedness and math motivation, and gender and math motivation

## **Giftedness, Talent Development, and Motivation**

There are several definitions of giftedness that incorporate or address motivation in some way. All of these definitions are related to talent development as a framework of giftedness. In addition, other research has documented patterns of motivation in highly talented people.

### **Three-Ring Conception of Giftedness (TRCG)**

Joseph Renzulli's TRCG, derived in 1977, formally broadened the definition of gifted and talented to include above-average ability, creativity, and task commitment. He chose *above-average ability* as a criterion instead of *high-ability* because "... research suggests that, beyond a certain level of cognitive ability, real-world achievement is less dependent on ever-increasing performance on skills assessment than on other personal and dispositional factors (e.g., task commitment and creativity)" (Renzulli, 2012, p. 153). Overall, his view of giftedness is not as a fixed entity but as a set of behaviors that occur developmentally and that are used for problem-solving (Renzulli, 2012). Renzulli defined task commitment as focused motivation (2005).

### **The Talent Development Project**

In 1985, Bloom and his team published the results of his Talent Development Project in which they studied elite athletes (swimmers and tennis players), scientists (mathematicians and neurologists), and artists (sculptors and pianists). They revealed several commonalities among these people, some of which were: their talent was identified at a young age, they sensed that they had a special talent, they had a great deal of intrinsic motivation for studying their talent domain, and they had very supportive families who made sacrifices for their talents. They were also able to document common

developmental phases of learning in each talent area. Each phase (early, middle, and late) was linked to teachers of increasingly sophisticated levels of expertise in the talent field (Sosniak, 1985). Though Bloom did not propose a formal definition of giftedness or talent development, it is noteworthy that he and his team discovered that intrinsic motivation was a common characteristic of highly talented people.

### **School-Based Conception of Giftedness (SCG)**

The SCG, originally espoused by Coleman in 1985 and Coleman & Cross in 2001, was clarified in 2005 (Cross & Coleman, 2005). This conception defines giftedness as potential for advanced learning in a school domain [for example, in the domain of math] in the early school years that must turn into advanced development and/or creative production in the secondary school years. High motivation in the student's talent area is an expectation. The authors summarize their definition as such:

Giftedness, therefore, represents a complex series of interactions that include the coordination of many traits of the individual student, such as motivation and perseverance, with context variables such as teacher expertise and opportunities for practice, along with the general ability levels of the individual in terms of academic domains, and levels of creativity. (p. 62)

### **Triarchic Theory of Human Intelligence (TTHI)**

Robert Sternberg's TTHI defined three kinds of intellectual giftedness: analytic ability (being able to analyze a problem and understand its parts), synthetic ability (creativity, intuition, insightfulness), and practical ability (the application of analytic and synthetic ability to everyday situations). Each form of giftedness has underlying concepts, but practical intelligence is about students building on their strengths [or talent

areas] and shoring up, or compensating for, their weaknesses. He further states, “I do not believe that intelligence is the whole story to giftedness. Creativity is important... as are personality dispositions and motivational states” (Sternberg, 1991, p. 53). His model of giftedness, called “Wisdom, Intelligence, Creativity Synthesized (WISC),” combines his three types of intelligence (analytical, creative, and practical) with creativity and wisdom in order to identify giftedness. His model also stresses that motivation and energy are important variables for gifted identification (Sternberg, 2005).

### **Talent Development Mega-Model**

Most recently, Subotnik et al (2011), have proposed a new Talent Development Mega-Model. According to this model, giftedness and talent are only partly responsible for ability in a talent domain. Psychosocial factors such as motivation, passion, and interest play a large role in how much students achieve in their identified talent domain. In fact, these researchers have identified the psychosocial factor of motivation as a contributor to giftedness. They contend that the amount of effort and persistence that students put into their talent area will be the deciding factor in whether they reach the highest levels of creative production in their area. Further, it is believed that these types of psychosocial skills can be taught by teachers. Thus, their model is a two-stage talent development process- *talent identification* in specific domains and *talent promotion* to properly guide and instruct the student in his or her talent area and in psychosocial factors such as motivation.

### **Conclusion**

In light of these definitions and studies of giftedness and talent development by Bloom, (1985); Cross & Coleman, (2005); Renzulli, (2005, 2012); Sternberg, (1991,

2005); and Subotnik et al, (2011), it is clear that motivation is an important component of giftedness, that motivation can be nurtured, and that early identification of talent is necessary so teachers have more time to train students in the content and to develop psychosocial variables (such as motivation) within them that will help them to achieve. Subotnik et al (2011) support early talent identification for these very reasons. In addition, based on 20 case studies of eminent mathematical researchers in the United States, Bloom (1985) determined that the talent development trajectory for math starts in the elementary years. Further, the National Association for Gifted Children recommends that all students from elementary school through high school take the most challenging math and sciences courses possible each year (Adams, Chamberlin, Gavin, Schultz, Sheffield, & Subotnik, 2009). Adams et al state:

The goal and purpose of discovering potential in the STEM areas should be to maximize the number and levels of promising students and not to limit the numbers of students in specialized programs. We must recognize that ability, motivation, beliefs, and experiences are not fixed and must be developed, supported and celebrated. (p. 2)

The present study will explore a specific type of motivation in elementary school-aged students identified as having high math ability— math academic intrinsic motivation. Learning more about the math motivation of high-ability math students of both genders will broaden our knowledge of how motivation plays into math achievement and goal orientation.

## Theories of Motivation

Motivation can most simply be defined as, "... the process whereby goal-directed activity is instigated and sustained," (Pintrich & Schunk, 1996, p. 4). There are myriad theories of motivation, several of which have been used in studies of the gifted, such as self-efficacy theory, attribution theory, expectancy-value theory, goal orientation theory, and intrinsic motivation theory (Clinkenbeard, 2012; Dai, Moon, & Feldhusen, 1998). In addition, there are multiple notions of motivation within each broad theory. Two of the aforementioned theories are most relevant to this study: intrinsic motivation and goal orientation. A discussion of Gottfried's construct of *academic intrinsic motivation* is related as an outgrowth of intrinsic motivation, as well.

### Intrinsic Motivation Theory

Many researchers have contributed to the understanding of intrinsic motivation. Deci gives a thorough overview of motivation theories and intrinsic motivation in his book, *Intrinsic Motivation* (1975).

According to Deci, there are four schools of thought in regard to motivation: *behavior theories* involve stimuli and responses, *affective arousal theories* are concerned with the affect [feelings], *cognitive theories* center on the thought processes of people, and *humanistic theories* stress the experiences of people. Intrinsic motivation falls into the cognitive camp of theories. Deci, 1975 says:

A cognitive approach to motivation proposes that people make choices about what to do on the basis of their goals (or desired end states) and their assessment of whether various behavioral alternatives will lead them to these end states. This

approach views humans as striving to satisfy their needs by setting goals and choosing behavior that they believe will allow them to achieve these goals. (p. 16)

Deci notes that a basic view of intrinsic motivation would be that activities that are intrinsically motivated have no rewards other than the activity itself. However, Deci and other researchers state that there are “internal consequences” (Deci, 1975, p. 24) that serve as rewards for intrinsically motivated behavior. Deci addressed these internal consequences through his research, showing that people have a need to feel “competent and self-determining” (Deci, 1975, p. 57). These feelings cause two types of behaviors in people: challenge-seeking behavior and challenge-conquering behavior. Those who are looking for challenge, the first type of behavior, are careful to pick situations that provide optimal challenge for them (not too hard or too easy). For example, boredom might motivate a person to find a challenge that would alleviate the boredom. On the other hand, fear of a difficult challenge will motivate a person to seek out a challenge that she feels is more commensurate with her ability. People engaging in the second type of behavior are looking to conquer challenge. These people are trying to make a situation less uncertain in order to create congruence between their cognitions and their behavior. In sum, the need for people to feel self-determining and competent is the psychological basis of Deci’s conception of intrinsic motivation. He thus defined intrinsic motivation as: “Intrinsically motivated behaviors are behaviors which a person engages in to feel competent and self-determining” (Deci, 1975, p. 61). He further characterized intrinsic motivation as innate and that all humans have the need for competence and self-determination.

**Academic Intrinsic Motivation.** Gottfried (1985) proposed the construct of *academic intrinsic motivation*, a special type of intrinsic motivation. This construct is intrinsic motivation that is related to school and is "... defined as enjoyment of school learning characterized by an orientation toward mastery; curiosity; persistence; task-endogeny; and the learning of challenging, difficult, and novel tasks," (p. 632). Her construct was influenced by several motivation theorists: Berlyne; Brophy; Deci; Harter; Maw; Nicholls; Pittman et al; and White.

**Berlyne (1971).** Berlyne discussed intrinsic motivation as a function of information processing in the brain. This processing is called *collation*; information coming into the brain is collated with items already stored in the brain and/or with items being processed simultaneously. The two types of collation are *comparison*—deciding how the new information relates to other information, and *synthesis*—grouping the new information into patterns. The end product of collation is either a rejection of the information as irrelevant or as an incorporation of the information that will translate into action. Collation is linked to intrinsic motivation; factors such as ambiguity, surprise, novelty, and complexity are essential to intrinsic motivation because they require the collation of distinct information. Presumably, this distinct information will be incorporated into action.

Berlyne further discussed the idea of the brain undergoing *specific exploration* and *diversive exploration*. The purpose of specific exploration is to gain specific information to satisfy some gap that the person has. Diverive exploration is classified as entertainment or play, its goal being to afford variety to the person. Both of these types of exploration are impacted by different motivational states. Berlyne identified curiosity as a

necessary condition for specific exploration and boredom or sensory deprivation as a necessary condition for diversive exploration.

To synthesize Berlyne's ideas, it can be said that a person in a curious state of mind would seek out specific information in order to satisfy her curiosity by filling a gap in her knowledge. The process of gathering this information would trigger the process of collation in the brain. Novel and/or complex information would cause the person to take action on the information in some way, thus satisfying her curiosity and filling any holes in her knowledge. This entire process is central to intrinsic motivation. Finally, Berlyne suggested that society should want students to have fun in school and to not be bored. "Education based on intrinsic motivation has the further attraction that it seems to be enjoyable," (Berlyne, 1971, p. 193).

**Brophy (1983).** Brophy made several contributions to the motivation literature. He pointed out that most motivation research focused on play situations involving free choice and physical activities and could not be easily generalized to classroom settings which comprise work situations and cognitive activities. He defined *student motivation to learn* as both a general trait and a specific situational state. As a general trait, student motivation to learn involves joy and pride in the process and outcomes of obtaining new knowledge and skills. In a specific situation state, it involves purposeful engagement in tasks in order to master new concepts and skills. He further noted that teachers can kindle student motivation in many ways, one of the ways being to consider students' attitudes toward classroom assignments. These attitudes can be task-endogenous— "the processes involved in engaging in the task and the learning it engenders" (Brophy, 1983, p. 206)— or task-exogenous—"focused on the self rather than the task, or on the anticipated

consequences of task performance” (Brophy, 1983, p. 206). He stated that most research on classroom motivation has centered on controlling student behavior by manipulating task-exogenous factors rather than cultivating intrinsic motivation through task-endogenous factors.

*Deci (1978)*. Deci described several characteristics of intrinsically motivated learning, which include people learning at their own pace about things that interest them, undergoing trial and error in their learning, pursuing their interests and curiosity, developing their potential as they experience it, and being self-directed. Further, he noted that most schools utilize extrinsic motivational systems (such as grades, stickers, etc.) that often undermine intrinsic motivation; he cited research showing that rewards can dampen a love of learning (Deci, 1978).

*Harter (1981)*. Harter defined intrinsic motivation as “an orientation toward learning and mastery in the classroom” (Harter, 1981, p. 310), and contrasted it to extrinsic motivation. Through the development of her student self-report scale to measure intrinsic motivation in elementary-aged children, Harter discerned five subscales of intrinsic versus extrinsic motivation. They are: a preference for challenge versus a preference for easy work, curiosity/intensity versus pleasing the teacher/getting grades, independent mastery versus dependence on the teacher, independent judgment versus reliance on teacher’s judgment, and internal criteria versus external criteria. Through further examination, Harter determined that only three of these subscales were truly related to motivation— challenge, curiosity, and mastery; the other two were more informational about the child’s decision-making.

**Maw (1971).** Maw's research focus was on curiosity. He determined that a child shows curiosity when he:

(1) reacts positively to new, strange, incongruous, or mysterious elements in his environment by moving toward them, by exploring them, or by manipulating them; (2) exhibits a need or a desire to know more about himself and/or his environment; (3) scans his surroundings seeking new experiences; and/or (4) persists in examining and exploring stimuli in order to know more about them. (p. 92)

Maw believed that all motivation is intrinsic and that there is no extrinsic motivation. There may be extrinsic rewards, incentives, and reinforcements, but none of those things impact curiosity except in the affective realm.

**Nicholls (1983).** Nicholls discussed three types of motivation: *extrinsic involvement*— the student learns in order to gain praise or a token; learning is a means to an end; the reward is the focus; *ego-involvement*— the student doesn't learn in order to understand something new, but to avoid looking stupid; learning is not an end in itself; the self is the focus; and *task-involvement*— the student learns in order to understand something new; learning is the end in itself; the task is the focus. He classified ego-involvement and task-involvement as true achievement motivation because the goal of each is to advance or exhibit ability. With task-involvement, students judge their ability against their own prior performance and view learning as related to effort. The more effort expended, the more learning occurs. In addition, students will feel competent when learning something new or when increasing their performance. With ego-involvement, students judge their ability against the performance of others. If someone else has learned

the same thing as the student with less effort than the student expended, the student will feel incompetent. Thus, ability is seen as capacity in relation to others' performance.

In regard to task choice, task-involved students are predicted to choose tasks with optimum challenge that will help increase mastery. Ego-involved students who believe they have high ability are predicted to pick tasks that are appropriately challenging, which will help them to show their ability. Ego-involved students who believe they have low ability are predicted to select either extremely difficult tasks because they wouldn't be expected to master such hard tasks or extremely easy tasks of which they are confident to be successful.

*Pittman, Boggiano, and Ruble (1983)*. These researchers explored the concepts of intrinsic and extrinsic motivational orientations. An intrinsic motivational orientation has two main elements: a person's choice of behavior will be motivated by curiosity or effectance [a need for mastery; see White, 1959, below], and a person will evaluate "behaviors, activities, and sources of stimulation as relevant or irrelevant to the satisfaction of intrinsic motivation," (p. 327). The characteristics of an intrinsic orientation include a need for mastery, challenge, novelty, and competence. An extrinsic motivational orientation also has two main elements: a person realizes that even an uninteresting activity can be useful for reaching a goal, and activities, behaviors, and sources of stimulation can also be classified as relevant or irrelevant to satisfying extrinsic needs. Characteristics of an extrinsic orientation include completing the task as quickly as possible and avoiding frustration while doing so in order to reach the actual goal. Overall, those holding an intrinsic orientation would likely prefer activities that are difficult, challenging,

unpredictable, fun, and allow for growth in competence. Those holding an extrinsic orientation would prefer activities that are easy and predictable.

**White (1959).** As of the late 1950's, according to White, many researchers had become disillusioned with the commonly accepted concepts of drives, instincts, and anxiety-reduction as the forces behind human behavior. White developed his own concept of *competence* to address the shortcomings of prior theories. He defined competence as “an organism’s capacity to interact effectively with its environment,” (White, 1959, p. 297). Further, competence has a motivational aspect, which he termed *effectance*. Its source of energy is the nervous system, not a drive or an external force. Effectance motivation produces behavior that is “selective, directed, and persistent and that instrumental acts will be learned for the sole reward of engaging in it” (White, 1959, p. 323). White noted that satisfaction— more specifically termed “a feeling of efficacy”— is necessary to effectance motivation (White, 1959, p. 329). Harter characterized effectance motivation as causing behavior that is geared toward mastery (Harter, 1981).

**Summary.** As mentioned, ideas from the eight researchers previously described were influential to Gottfried and her conception of academic intrinsic motivation. Specifically, the different parts of her definition can be linked to the following researchers:

- enjoyment of school learning (Berlyne, 1971);
- an orientation toward mastery (Harter, 1981; Nicholls, 1983; White, 1959);
- curiosity (Berlyne, 1971; Deci, 1978; Harter, 1981; Maw, 1971);
- persistence (Maw, 1971);

- task-endogeny (Brophy, 1983); and
- the learning of challenging, difficult, and novel tasks (Berlyne, 1971; Harter, 1981; Pittman et al, 1983).

### **Goal Orientation Theory**

As with intrinsic motivation theory, many different researchers have contributed to the motivation literature on goal orientation theory (also known as *achievement goal theory*; Maehr & Zusho, 2009). Pintrich and Schunk (2002) give a thorough overview of this theory and its main researchers. According to them, *goal orientation* is not about the achievement goals a student has but about the purpose for the achievement goals, and it involves student judgment of performance against a self-imposed standard. There are two types of goal orientations common to the different goal orientation researchers: a mastery goal orientation and a performance goal orientation. *Mastery goals* concern learning in order to grow in competence, master a task, improve in some way, enjoy a challenge, etc. *Performance goals* concern learning in order to show one's ability, look competent, get recognition, perform better than others, or to avoid looking dumb. Different goal orientation researchers have differing names for mastery and performance goals. As cited in Pintrich and Schunk (2002, p. 214), Dweck and Leggett (1988) and Elliott and Dweck (1988) call them learning goals and performance goals; Maehr and Midgley (1991) call them task-focused and ability-focused; Nicholls (1984) calls them task-involved and ego-involved; and only Ames calls them mastery and performance goals (Ames, 1992; Ames & Archer, 1987, 1988). Recently, Hulleman, Schragar, Bodmann, and Harackiewicz (2010) undertook a meta-analysis to determine if achievement goal researchers are measuring similar constructs but calling them different

names or measuring different constructs and calling them the same names. Hulleman and his colleagues pointed out the confusion of these definitions and posit that the researchers might be undermining their work because the various constructs are not aligned. In fact, after analyzing 243 correlational studies involving over 91,000 subjects, Hulleman et al found that goal theory researchers are indeed measuring different constructs, yet calling them the same names. They conclude, “This discrepancy between conceptual and operational definitions and the absence of goal-relevant language in achievement goal measures may be preventing productive theory testing, research synthesis, and practical application,” (Hulleman et al, 2010, p.422). The issues related to construct definition do not negate or devalue the research on goal orientation theory that has already been carried out. The researchers point to the fact that more closely aligned constructs could provide for more powerful future research.

Goal orientations are also related to affective, cognitive, and behavioral outcomes. For example, pride (an affective outcome), self-monitoring (a cognitive outcome), and risk-taking (a behavioral outcome) are all outcomes related to mastery goals. In addition, personal characteristics—such as gender, age, and ethnicity— and classroom context— such as classroom organization and task structure— can serve as predictors of which type of goal orientation students might have (Pintrich & Schunk, 2002).

As mentioned, many researchers have contributed to the understanding of goal theory. The work of Carol Dweck (1999, 2006) based on studies of students from elementary school through college will be used in the current study to interpret students’ goal orientation as analyzed on the CAIMI Math subscale. Dweck’s definition of learning goals and performance goals is similar to Nicholls’ (1983) definition of mastery goals

and performance goals that influenced Gottfried's construct of academic intrinsic motivation. Dweck's theory, however, is well-suited to schools and seems most directly related to the present study.

*Dweck (1999)*. Dweck's (1999) model of achievement motivation has several components— intelligence theories, goal orientations, reactions to failure, and viewpoints of effort. According to Dweck, students' implicit beliefs about intelligence are what influence their goal orientations in achievement situations, their reactions to failure, and their outlay of effort. Students who hold an *entity theory* of intelligence believe that intelligence is fixed and cannot change regardless of how much effort is expended; those who hold an *incremental theory* of intelligence believe that intelligence is malleable, can be nurtured, and can grow. More recently, entity theory has been named a *fixed mindset* and incremental theory has been named a *growth mindset* (Dweck, 2006).

The beliefs that students have about their intelligence create two different types of goal orientations for achievement— a *performance goal* orientation or a *learning goal* orientation. The performance goal orientation is associated with the entity theory of intelligence. Students who hold this goal orientation are motivated by the goal of looking smart and not looking dumb. On the other hand, the learning goal orientation is associated with the incremental theory of intelligence. Those who hold a learning goal orientation are motivated by the goal of increasing their ability and mastering new things (Dweck, 1999).

Students' beliefs about intelligence also predict how students will handle failure. Dweck observed two types of reactions to failure of students of equal ability and performance who were involved in her puzzle-solving studies— they either exhibited a

*helpless* pattern or a *mastery-oriented* pattern in the face of failure. Belief that intelligence is an entity predicts that students will exhibit a helpless pattern in a failure situation; this pattern is also associated with performance goals. Belief that intelligence is incremental predicts that students will exhibit a mastery-oriented pattern in a failure situation; the mastery-oriented pattern is associated with learning goals. In Dweck's studies, students demonstrating a helpless pattern doubted their intelligence, displayed negative emotions, had lower persistence, lost faith in their ability, and so forth. To these students, failure was a direct attack on their intelligence; to fail meant that they were not smart. Students demonstrating a mastery-oriented pattern did not seem to perceive their inability to solve the puzzles to be a failure; they looked at the difficult puzzles as nothing more than problems to solve. They engaged in self-instruction or self-monitoring, they persevered, and they maintained a positive attitude. To them, failure was just another obstacle to overcome and an opportunity to do something new (Dweck, 1999). Other behavior patterns associated with these goal orientations are:

- a. students who value performance goals and have high confidence in their abilities usually choose tasks in which they are confident that they can do well and seek to master those tasks;
- b. students who value performance goals and have low confidence in their abilities usually choose tasks that are easy and display learned-helplessness when they face problems; and
- c. students who value learning goals, whether they have high or low confidence in their abilities, usually choose tasks that emphasize learning at the risk of making

mistakes in order to master the new task and increase their abilities (Elliott & Dweck, 1988).

Theories of intelligence also create different meanings of effort for students. Students holding the entity theory of intelligence saw effort in a negative light. To expend effort on a task meant that they were not smart; working hard at a task meant that they were not good at it. Even if the task was very hard, these students believed that if they were smart, they should not have to work hard. The incremental theory of intelligence produces a different perspective on effort. Students adhering to this theory saw effort as a way to use their ability and reach their potential. They believed that even very smart people had to give effort.

In sum, students' beliefs about intelligence create motivational frameworks under which the students operate and their beliefs affect them in several ways:

They affect (a) their goals in school— whether students are interested in looking smart or in learning; (b) their belief in the usefulness of effort— viewing effort as something negative or something positive, (c) the way they explain their failures— as conveying a lack of ability or simply a lack of effort or a poor strategy, and (d) the strategies they use after a setback— giving up or persevering. (Dweck & Master, 2009, pp. 124)

### **Summary for Motivation Theories**

As noted by Clinkenbeard (2012) and Dai, Moon, and Feldhusen (1998), both intrinsic motivation theory and goal orientation theory have been studied with gifted populations. In addition, motivation has been shown to exist in children, and each of these theories has been studied with students of elementary age. Thus, it is possible to

research the motivation of gifted elementary students. There is a call in the field of gifted education to identify talent at young ages and to research the relationship between motivation and talent development (Subotnik et al, 2011). The current study can help expand the literature base by exploring the relationships between math achievement of high-ability and gifted students and their math motivation, gender, and goal orientation.

For the present study, intrinsic motivation theory as presented by Deci (1975) and goal orientation theory as presented by Dweck (1999) were the overarching psychological frameworks, and academic intrinsic motivation in math (Gottfried, 1985) was the specific construct being researched. Gottfried has conducted several studies of her construct, two of which focused specifically on math, and one of which focused on gifted students. She has developed an instrument (the CAIMI) to measure her construct and has validated it with elementary-aged students. Her instrument contains two questions within the math subscale that can be interpreted in relation to students' goal orientation, as well. For these reasons, the present study focuses on the academic intrinsic math motivation and the goal orientation of high-ability elementary-aged math students. These constructs are also analyzed in terms of gender in order to build knowledge of girls and the talent development process in STEM-related trajectories.

### **Motivation Literature**

There is much research on motivation, but little on math motivation of young, high-ability math students. It is important to review several bodies of motivation literature to understand the context within which the current investigation will be couched: math motivation and math achievement, giftedness and motivation, giftedness and math motivation, and gender and math motivation.

## **Math Motivation and Math Achievement**

Few studies have focused specifically on the math motivation and math achievement of students at the elementary level. Murphy and Alexander (2000) noted only seven studies of math and motivation of elementary school students from the 1990's. A few more current, international studies have reported on math motivation, but none of them other than Gottfried's focus solely on intrinsic motivation or academic intrinsic motivation in math in relation to math achievement. A look at the findings of these current studies, then a review of the body of work contributed to the motivation field by Gottfried and her colleagues follows.

**Current studies.** Aunola, Leskinen, and Nurmi (2006) studied 196 Finnish 5 and 6 year-old children over the course of two years. Their goal was to learn more about students' task motivation and math performance at the transition into primary school. They measured math performance during preschool, the beginning and end of first grade, and the beginning of second grade. Then they measured task motivation using the task-value scale for children during the first and second grade data collection points. This scale contained three questions about math based on Eccles' and her colleagues' expectancy-value model (2000). Even at such a young age, a high level of performance in math increased math task motivation and predicted future math performance. Findings of a 2012 study by Frierberger, Steinmayr, and Spinath complemented Aunola, Leskinen, and Nurmi's work. The researchers examined 459 German 2<sup>nd</sup> graders in order to determine the role of student competence beliefs and teachers' perceived ability evaluations on intrinsic motivation and achievement in math. The researchers used Wigfield & Eccles' (2000) expectancy-value theory as their motivational framework.

Their survey also had three questions about math. Findings indicated that teacher's perceived ability evaluations had an indirect effect on students' math achievement and intrinsic motivation. Both of these studies verified that evidence of motivation occur in younger ages than previously thought in the field of motivation research, thus providing new knowledge to the field concerning intrinsic motivation and math achievement. The current study is different from these works in several important ways: It analyzes a different age group (upper elementary) in a different country (the United States), it applies a different theoretical framework for motivation (intrinsic motivation/goal orientation versus expectancy-value), it has a different focus (math academic intrinsic motivation instead of motivation in math), and its measurement tool is different (a 26-question, validated, math motivation survey vs. a three-question survey about math).

**Gottfried's studies.** Gottfried contributed a new construct to the motivation literature, academic intrinsic motivation, and constructed and validated a motivation measurement tool, the CAIMI, based on her construct. She has spent years doing follow-up analyses on a particular group of subjects, 114 students she began studying in 1979 at one-year of age from a project called the Fullerton Longitudinal Study. A look at her work is justified because the information she gleaned about academic intrinsic motivation in math and its relationship to math achievement is integral to the present study.

In 1985, Gottfried validated her motivation survey, the Children's Academic Intrinsic Motivation Inventory (CAIMI), through three studies. This survey was based on her construct of academic intrinsic motivation and assessed upper elementary and junior high school-aged students' level of motivation for five areas: reading, social studies, math, science, and a general orientation toward school learning. Gottfried found that

achievement in every area except social studies was significantly correlated with CAIMI scores, accounting for 20% of the variance in school achievement. Most interestingly, she found that math motivation scores on the CAIMI were the most highly correlated with math achievement across all three studies. Thus, "... the Math CAIMI subscale was a significant, independent, and unique predictor of math achievement," (Gottfried, 1985, p. 639).

Gottfried (1990) next validated another version of the CAIMI—the Y-CAIMI—through a longitudinal analysis of the Fullerton Longitudinal Study students at age 7, 8, and 9. She determined that academic intrinsic motivation was a valid construct for students as young as age 7 and learned that children with higher motivation at ages 7 and 8 were likely to have higher motivation at age 9, as well, thus showing stability of the construct. Motivation and achievement were positively correlated between all subject areas of the Y-CAIMI, though the correlations were not as stable at ages 7 and 8 as they were at age 9. Math achievement scores on the Woodcock-Johnson test at ages 7 and 8 showed the strongest correlation with math motivation at age 9. As in the CAIMI study with upper elementary and junior high students in 1985, math appeared to be an area of uniqueness with the younger students, too. Math motivation levels at age 7 and 8 predicted motivation at age 9 independent of achievement, intelligence, and socioeconomic status. Multiple regressions also showed that math achievement at age 7 predicted math motivation at age 9.

In 2001, Gottfried and her colleagues collected more data on the 1990 sample to study the continuity of academic intrinsic motivation from elementary school through high school (Gottfried, Fleming, & Gottfried, 2001). Their findings indicated that the

construct was stable through the school age years, with the motivation level at each age predicting the motivation level at each successive age. Further, academic intrinsic motivation declined significantly from late elementary school until roughly age 16 in all subject areas (as predicted by the authors based on prior research they reviewed). The largest decline, however, was in math motivation. They suggested that possible reasons for the decline in math motivation was the difficulty of math in later school years, students holding a lower concept of their ability, and the emphasis on grades for college admission, among other reasons. Due to the correlation between achievement and academic intrinsic motivation (as shown by Gottfried in 1985) and the decline of academic intrinsic motivation as children get older, the authors state that, "The data imply that if one is to intervene to enhance academic intrinsic motivation, it had better be early in a child's schooling," (p. 10). This would be especially true in math because math has the highest correlations between achievement and motivation and the largest decline in motivation.

Gottfried, Marcoulides, Gottfried, Oliver, and Guerin (2007) used the same sample and data from Gottfried's 1990 study and applied multivariate latent change modeling to it in order to explain the decline in math motivation from late childhood to late adolescence. To do this, they examined the patterns of math achievement through the years as contributors to the decline in math motivation. They found that math achievement was "... a significant contributor to the developmental decrease in intrinsic math motivation from childhood through adolescence," (p. 325). Math achievement was directly related to future achievement and future motivation levels in math. Based on this finding, the authors suggest that educators

intervene early with students who demonstrate low math academic intrinsic motivation and/or low math achievement.

Most recently, Gottfried and her colleagues completed another analysis on this same group of students, essentially having followed these children for 20 years, from ages 9-29 (Gottfried, Marcoulides, Gottfried, & Oliver, 2013). This time, their goal was to determine how math academic intrinsic motivation and math achievement related to high school math course accomplishments and educational attainments. They postulated that due to the decline in math motivation and math achievement over time, those students with lower math motivation and lower math achievement would take fewer math courses in high school and attain lower levels of education. To study this, they applied a longitudinal multivariate model to the collected data: years of CAIMI Math scores, math grades, math achievement test scores, high school math classes according to the students' high school transcripts, adult educational attainment, and a unique construct they derived called "Math Course Accomplishments Construct" (created from measuring the number of math courses taken, the highest level of math courses taken, and the number of Honors/Advanced Placement/International Baccalaureate math courses taken). Indeed, the data supported their hypothesis: Students with lower math motivation levels also had lower math achievement and fewer accomplishments in math courses as well as lower educational attainment. Further, their analysis supported other research that showed that the higher the level of math completed in high school, the higher the chances of the student going to and graduating from college. The authors stated that, "Students who, from an early age, are more intrinsically motivated to take on more challenging tasks and show greater mastery and proficiency in their achievement are significantly more likely

to advance further in their educational attainment,” (p. 83). Based on these findings, Gottfried et al (2013), strongly encourage educators to screen students for math motivation at a young age in order to provide interventions for those with low math motivation. Students with low math motivation also tend to have low math achievement. Therefore, these students are at great risk of not fulfilling their math potential.

In sum, there are several important findings that can be garnered from Gottfried’s research regarding math motivation as measured by the CAIMI and Y-CAIMI.

1. Academic intrinsic motivation in math is a stable construct that can be measured in students as early as age 7.
2. Math motivation levels at early ages can predict math motivation at later ages.
3. Math academic intrinsic motivation and math achievement are highly correlated.
4. As students age, math motivation declines, as does math achievement, and math achievement becomes a stronger predictor of future math motivation as well as future math achievement.
5. Students who have lower levels of math academic intrinsic motivation also have lower math achievement, take fewer challenging math courses in high school, and attain lower educational levels.
6. Conversely, students with higher levels of math motivation have higher math achievement, take more challenging math courses in high school, and are more likely to attend and graduate from college.

The current investigation utilizes the math subscale of the CAIMI with a specific population of elementary-aged students— high-ability math students at the beginning of the STEM pipeline— in order to study within-group differences for gender and math

academic intrinsic motivation. It also imposes Dweck's (1999) conception of performance and learning goals onto Gottfried's (1985) tool in order to analyze these students' goal orientation. Math achievement information will be collected, as well, to use in analyses with the CAIMI math data. The present study is the only piece of research to date, other than Gottfried's own work, which employs the CAIMI as a measurement of math motivation.

### **Giftedness and Motivation**

There is much research on motivation, in general, but less on gifted students and motivation. Dai, Moon, and Feldhusen (1998) conducted a literature review of research on achievement motivation and the gifted from a social cognitive perspective. They concluded that most research studies fell under the auspices of four constructs of motivation: perceived competence and self-efficacy, attributions, goal orientation, and intrinsic motivation. They also noted that all of the research they reviewed utilized between-group designs (gifted and non-gifted), and gifted students almost always showed higher levels of motivation than non-gifted students. Among other ideas, they suggested that future research on motivation and the gifted should study within-group designs, which the present study does.

Clinkenbeard (2012) examined numerous motivation theories such as expectancy-value theory, intrinsic and extrinsic motivation theories, goal theories, perceptions of the self-theories, and attribution theory to determine their implications for gifted students. She concluded that all of these theories can apply to gifted students. However, she noted that only about 20% of the studies she researched were empirical, and almost all of those involved between-group designs (gifted and non-gifted). She also stated that, "There are

differences in motivational portraits of the gifted based on developmental level, race, ethnicity, socioeconomic status, gender, and the existence of other exceptionalities,” (p. 628), though she gave no further information to expound upon the differences. The current research study helps fill in the portrait of math motivation of the gifted by developmental level and by gender.

Despite little empirical research regarding motivation and the gifted, there are some noteworthy studies based on motivational theories. Vallerand, Gagné, Senécal, and Pelletier (1994) utilized Deci’s (1975) concept of intrinsic motivation to study 135 gifted and non-gifted French-Canadian 4<sup>th</sup>–6<sup>th</sup> graders using Harter’s Intrinsic/Extrinsic Orientation Scale and the Cognitive Perceived Competence Scale. They found that gifted students had higher levels of both intrinsic motivation and perceived competence than did their non-gifted peers.

In 1996, Gottfried and Gottfried also found that gifted students had significantly higher academic intrinsic motivation than their non-gifted peers. These students, both gifted and non-gifted, were members of the Fullerton Longitudinal Study in California and had been studied by these researchers since they were one year old, beginning in the fall of 1979. At age 8, the students were designated as gifted if they obtained a score of 130 or greater on the Wechsler Intelligence Scale for Children- Revised (WISC-R). Motivation data had been collected on these students since age 1, first by using the Bayley Behavior Record, next by using the Y-CAIMI (Youth- Children’s Academic Intrinsic Motivation Inventory), and at ages 9, 10, and 13 by using the CAIMI. Based on the results of their study, the authors suggest that motivation is a developmental process that is an important part of developing giftedness, because these gifted students had

shown high intrinsic motivation since they were as young as 18 months old. As an interesting side note, the authors have since proposed the concept of *gifted motivation* as a separate construct of giftedness based on their findings that indicated intellectually gifted students in their sample had significantly higher academic intrinsic motivation than their average-ability counterparts (Gottfried & Gottfried, 2004).

McCoach and Siegle (2003) conducted a within-group study comparing 122 gifted achieving and 56 gifted underachieving high school students across the nation. They found that gifted achievers scored significantly higher on motivation/self-regulation and on goal valuation than did gifted underachievers. They noted that the types of goals students set for themselves and the effort they expended toward those goals were the main characteristics that set apart gifted achievers from gifted underachievers.

Through the findings of these studies, motivation has been recognized as a valid construct within children. This literature further illustrates that gifted students have higher motivation levels than non-gifted students and gifted achieving students have higher motivation levels than gifted underachieving students. In addition, based on Gottfried and her colleague's work with the Fullerton Study (1990, 1996, 2001), it appears that motivation could be a developmental process because they were able to detect it in their cohort from age 1 to age 18. In light of the aforementioned conclusions, it is important to identify math talent in children to influence their motivational patterns in order to help them reach their math potential. The present study elucidates information about motivation at the upper elementary level.

### **Giftedness and Math Motivation**

There has been one noteworthy, between-groups, international study of gifted students and motivation in mathematics (there is also a study of gender, giftedness, and math motivation summarized in the section on gender). Vlahovic-Stetic, Vidovic, and Arambasic (1999) studied 147 gifted high-achieving, gifted underachieving, and non-gifted 9- and 10-year-old students in Zagreb, Croatia. They found that, in comparison to the non-gifted students, the gifted students, both achieving and not achieving, had "... higher levels of intrinsic orientation toward mathematics, lower math anxiety, lower attribution of success to external factors (effort), as well as lower attribution of failure to external factors and abilities" (p. 46). These gifted students also had a fairly high interest in math, involvement in math schoolwork, and inclination to tackle math tasks independently. The present study differs from the Vlahovic-Stetic, Vidovic, and Arambasic study in that it samples students in the United States, uses a within-group design, and reports results by gender, thus increasing the literature base in giftedness and math motivation.

### **Gender and Math Motivation**

In 2008, Preckel, Goetz, Pekrun, and Kleine undertook a between-groups study comparing gender differences of 181 German gifted and 181 average-ability 6<sup>th</sup> grade students for achievement, self-concept, interest, and motivation in math. The results of this study indicated that gifted boys and girls had higher math achievement than their non-gifted peers, and girls across both groups had lower levels of motivation (as measured by performance goal orientation and mastery goal orientation), interest, and self-concept than did boys. Gifted boys had the highest levels of interest, self-concept,

and motivation toward math of all groups. Most interestingly, they found that gender differences on the variables were more significant between gifted girls and boys than between the gifted and the non-gifted. Thus, gifted girls and boys differed more in motivation, achievement, interest, and self-concept in math than did gifted and non-gifted students— an unexpected finding.

Citing the shortage of women in STEM-related careers, Leaper, Farkas, and Brown (2012) set out to determine the factors that may impact US adolescent girls' motivation toward math and science by studying 579 ethnically diverse girls, ages 13—18. They found that the girls' perceived support of math and science by mothers and peers was positively related to math/science motivation of the girls. In addition, "Girls were more likely to have strong M/S motivation if they experienced less conformity pressure from parents, they endorsed gender equality, or they had been exposed to feminism" (p. 276). The variables not associated with math/science motivation in girls were gender typicality, peer pressure, or contentedness with gender role. The current study adds to these findings by comparing the motivational scores of both genders and by analyzing the goal orientation of the students as factors that might impact their motivation.

A study by Watt, Shapka, Morris, Durik, Keating, and Eccles (2012) of gendered motivational processes related to high school math participation, educational aspirations, and career plans compared samples of boys and girls from Canada ( $n=471$ ), the US ( $n=418$ ), and Australia ( $n=358$ ) at Grades 9/10 and 11/12. Math motivational beliefs were measured using Eccles' expectancy-value model as a motivational framework and focusing on questions for intrinsic value, perceived ability, attainment value, success

expectancy, and utility value. Results indicated that female adolescents in the Australian sample had significantly lower intrinsic value than did male, and female adolescents in the US and Canadian samples had significantly lower ability/success expectancy than did males. The authors raised a red flag about these findings: “Because ability/success expectancy and values are central to promoting male and female adolescents’ later mathematical, and nonmathematical, educational and occupational aspirations, gender differences in these motivations are of high concern,” (Watt, Shapka, Morris, Durik, Keating, & Eccles, 2012, p. 1605). The present study looks at younger students to learn about their motivation in math. This knowledge will allow educators to address high-ability math students’ high school math course trajectory, their educational aspirations, and their career plans while they are still young enough to benefit from motivation interventions.

### **Summary for Motivation Literature**

There are many theories of motivation that have been studied with elementary-aged students. Several of them have been explored with gifted students— self-efficacy theory, attribution theory, expectancy-value theory, goal orientation theory, and intrinsic motivation theory. Few empirical research studies have been conducted on gifted students using these motivation theories. Further, the majority of those that have been done utilize between-group designs and have used Eccles’ expectancy-value theory as a motivation framework. All of these studies indicate that gifted students have higher levels of motivation than non-gifted students. In addition, the studies that have been conducted on math motivation have found that gifted math students have higher levels of math motivation than their average-ability math peers. For the current investigation, Gottfried’s

construct of academic intrinsic motivation (1985), as an outgrowth of intrinsic motivation theory (Deci, 1978), will be used in conjunction with Dweck's (1999, 2006) conception of goal orientation in order to understand the math motivation levels, math achievement, and goal orientation of high-ability 5<sup>th</sup> grade math students of both genders.

## **Chapter 3**

### **Methodology**

It is clear that motivation is an important factor of student achievement. Many researchers consider motivation to be a crucial component of giftedness, yet the research on motivation and math talent development within gifted populations is scarce. The intent of this study was to measure high-ability math students' math motivation levels and math achievement to determine what relationships exist between the variables of math motivation, math achievement, goal orientation, and gender. This descriptive study included data points (i.e., gender, TOMAGS scores, end-of-semester math grades, and math motivation scores) for 97 high-ability 5<sup>th</sup> grade math students taking an accelerated 6<sup>th</sup> grade math class. The investigation serves as exploratory research to suggest lines of future research that could help schools retain gifted and potentially gifted math students in advanced math courses so that they may meet their math potential and remain in the STEM pipeline. Additionally, this study adds to the research base in gifted education regarding math motivation, math achievement, and goal orientation of high-ability math students. The questions explored were:

1. What is the math motivation level of high-ability math students?
2. What is the math achievement level of high-ability math students?
3. What is the goal orientation of high-ability math students?
4. To what degree is the math motivation level of high-ability math students related to their math achievement?
5. What is the math achievement level of high-ability math students for each goal orientation?

6. What is the math motivation level of high-ability math students for each goal orientation?

### **Subjects and Sample Selection**

The target population for this study was 5<sup>th</sup> grade high-ability math students who were placed in an accelerated math class (6<sup>th</sup> grade math). The accessible population was all of the 5<sup>th</sup> grade high-ability math students in a mid-sized, suburban, southeastern United States public school division from Spring of 2013 to Spring of 2014 (approximately 240 students). This sample was one of convenience that comprised students from four gifted 5<sup>th</sup> grade math classes from four different schools (one class per school) in which the high-ability 5<sup>th</sup> grade math students were taking 6<sup>th</sup> grade math. Students were selected by their schools for the 6<sup>th</sup> grade math class in one of two ways: either through gifted identification procedures that required the student to meet three of four criteria— a cognitive ability test score (CogAT) of 95<sup>th</sup> percentile or higher, a TOMAGS test score of 95<sup>th</sup> percentile or higher, a teacher behavioral checklist score of 95<sup>th</sup> percentile or higher, and/or a math product performance score of 90<sup>th</sup> percentile or higher; or through an alternate method of earning a Pass Advanced score on the 4<sup>th</sup> grade state math assessment (this would be a score in the range of 500-600 points) and a 92<sup>nd</sup> percentile or higher score on the TOMAGS. The teachers of the 6<sup>th</sup> grade math classes volunteered to participate in the study. There were 106 students in the original sample; data from 97 students was analyzed.

### **Instrumentation**

Two standardized measures were used in this investigation— a motivation instrument (from which math motivation and goal orientation information was derived) and a gifted math achievement test— as well as end-of-semester teacher-assigned grades.

#### **Children’s Academic Intrinsic Motivation Inventory (CAIMI)**

The CAIMI measures the academic intrinsic motivation of children through a 122-item self-report inventory. It has five subscales: Reading, Math, Science, Social Studies, and General Motivation. Each content area contains 26 questions and the general motivation section contains 18 questions. Most items are on a five-point Likert scale (choices include “Strongly Agree,” “Agree,” “Don’t Agree or Disagree,” “Disagree,” and “Strongly Disagree”), with two open-ended questions in each area. The inventory was designed to measure both high and low academic intrinsic motivation, with low scores corresponding to low motivation and high scores corresponding to high motivation (Gottfried, 1985). The maximum math motivation score is 124 ( $M= 100.0$ ,  $SD= 15.7$ ). Only the math subscale of the CAIMI was used to measure the math motivation and goal orientation of the students in this study. In addition, goal orientation was derived by the researcher by using the final two questions on the math subscale of the CAIMI, which ask students about good math grades versus learning more math and repeating tasks versus learning new things. Students scored either a 2, 3, or 4 for goal orientation. A score of “2” or “3” for these questions reflected a Performance Orientation, and a score of “4” reflected a Learning Orientation.

It is often a limitation to examine only one subscale of a test for statistical analysis because the reliability of tests is typically given for only the total test score.

Subscales usually have lower reliability than the whole test score (Gall, Gall, & Borg, 2007). However, Gottfried assessed internal consistency reliability for each subscale of the CAIMI through two studies, and reported reliability coefficients of .89 and .93 for the math subscale (Gottfried, 1986b). For the sample currently under investigation, Cronbach's alpha was .87. Thus, it was not a limitation to analyze the math subscale apart from the rest of the CAIMI in this study.

There was one review of the CAIMI in *Mental Measurements Yearbook*. According to Posey (1989), the CAIMI has good test-retest reliability with coefficients ranging from .66 to .76 and internal consistency coefficients ranging from .83 to .93. No differences were found as a function of IQ, race, or gender. CAIMI scores and achievement test results were correlated with coefficients ranging from .24 to .44. Motivation and achievement were largely independent, with achievement accounting for no more than 18% of the variance in CAIMI scores, but CAIMI scores in math were highly related to math achievement. In addition, teachers' ratings of children's motivation showed significant relationships with CAIMI scores in reading ( $r=.27$ ), math ( $r=.22$ ), and general motivation ( $r=.25$ ). The CAIMI was also significantly correlated with another measure of intrinsic motivation ( $r = .17$  to  $.64$ ; Posey, 1989); this measure was Harter's (1981) Scale of Intrinsic versus Extrinsic Orientation in the Classroom (Gottfried, 1986b).

Overall, Posey concluded that the CAIMI seemed to be a reliable instrument to use to measure academic intrinsic motivation, but took issue with the fact that the researcher used a small sample size that was not nationally normed to develop the inventory. Because of this, he advised that the tool can be used but caution must be

exercised when drawing conclusions that are not replicated from the original study (Posey, 1989).

### **Test of Mathematical Ability for Gifted Students (TOMAGS)**

The TOMAGS is an open-ended math test designed to assess talent in math through novel mathematical situations in order to identify giftedness in math. It is standardized, norm-referenced, and “requires students to use mathematical reasoning and problem-solving skills to understand how to communicate mathematically to solve problems,” (Ryser & Johnsen, 1998, p. 1). It has two levels of tests— Primary (grades 1-3) and Intermediate (grades 4-6). The test is untimed, though it can be completed within 30—60 minutes (Frary, 2001). Quotient scores from the Intermediate level were used as a norm-referenced measurement of high-ability 5<sup>th</sup> grade math students’ math achievement.

There are two reviews of the TOMAGS in *Mental Measurements Yearbook* (Frary, 2001; Harnisch, 2001). The first review, by Robert B. Frary from Virginia Polytechnic Institute and State University (2001), noted that the test had four norming samples, two each for primary and intermediate. Of each level of samples, one of the two comprised an identified gifted sample of children and the other a sample of children that was not identified as gifted. These samples produced two sets of norms: one set for the gifted population and one set for the general population. These norms are separated into eight 6-month age strata across the two levels of tests and yield scores called “quotients.” Further, the samples represented diverse ethnicity, geographic location, and socio-economic status and were appropriately distributed for gender and age. Coefficient alpha reliability ranged from .86 to .92. Content validity was established by aligning test questions to content recommendations from the National Council of Teachers of

Mathematics (NCTM). Concurrent validity was established through correlations between the TOMAGS and the Otis-Lennon School Ability Test (Total Index), the Cognitive Ability Test (Quantitative Index), and the Scholastic Achievement Test in Math; correlation coefficient scores ranged from .62 to .73. No evidence of bias in item performance by gender or ethnicity was found (Frary, 2001).

Overall, Frary recommends the use of the TOMAGS for identifying students who are gifted in math, with a few considerations:

- a. the TOMAGS is tedious to score due to hand-scoring and its open-ended nature;
- b. item dependence may artificially inflate the coefficient alpha because several sets of items require a student to get all parts correct or else they will get the entire set wrong;
- c. item dependency decreases the amount of subject matter that can be covered because fewer concepts that require several answers are used;
- d. the interpretation of the norms may be confusing because a student might have a high score in the norms for the general population but a low score for the gifted norms (the reviewer suggests to use only the general population norms for finding gifted math students and use the gifted norms to interpret the level of success that the students might have in the gifted program); and
- e. the number of students in each age stratum might have been too small for deriving the scores (quotients), with the possibility of some norm strata being based on 75 or fewer students (Frary, 2001).

The second reviewer of the TOMAGS, Delwyn L. Harnisch of the University of Nebraska-Lincoln, noted that the TOMAGS is skewed toward the NCTM standard of

geometry and spatial sense with 11 items testing this strand (in comparison, most standards have 4 items, and algebra and statistics and probability each have 7 items). Further, the norming sample for the general population mirrors the demographics in 1990 U.S. Census data; however, in a few areas (such as rural public school students), the TOMAGS has higher proportions of students than the Census indicated (44% rural students for TOMAGS Primary and 43% rural students for TOMAGS Intermediate). In addition, there were only 82 students in the age 12 norming sample, compared to 310 in the age 8 sample. Similar issues were found with the gifted norming sample. Finally, test-retest reliability was .84 (TOMAGS Primary) and .94 (TOMAGS Intermediate), inter-rater reliability scores were .99 (though this score does not provide evidence that the TOMAGS was scored accurately, only similarly), and evidence of construct validity should be more extensive. The reviewer recommends the use of the TOMAGS in finding students who are gifted in math by using the general population norms. He cautions that the TOMAGS should only constitute one source of information on math talent; other sources should also be used when identifying giftedness (Harnisch, 2001).

#### **End-of-Semester Teacher-Assigned Grades**

For this study, end-of-semester math grades were conceptualized as such: an “A” is considered “High Achievement (90-100),” a “B” is “Moderate Achievement (80-89)” a “C” is “Average Achievement (70-79),” and a “D” (60-69) or an “F” (59 and below) is considered “Low Achievement.” Grades were comprised of quizzes and tests, classwork assignments, participation (such as completion of homework and taking part in group work), and math journal activities. The number grade (i.e., 95) was used for all statistical

calculations. Table 1 includes a breakdown of each teacher's math grade composition, weighting, and types of graded assignments.

Table 1

*Teachers' Math Grading Practices*

Teacher	Composition of Math Grade and Weighting	Types of Graded Assignments
Teacher 1	Cumulative Review Assessments 50% Weekly Assessments 50%	Weekly and cumulative assessments
Teacher 2	Tests 35% Quizzes 25% Classwork 20% Homework 10% Participation 10%	Tests, Quizzes, Homework, and Classwork (a worksheet, a product from a math menu, a completed journal entry, etc.)
Teacher 3	Tests/Projects 45% Quizzes 40% Classwork 10% Homework 5%	Test, Projects, Quizzes, and Classwork (math station activities, independent work, partner work, participation)
Teacher 4	Tests-45% Quiz-30% Classwork-25%	Test, Quizzes, and Classwork (a worksheet, product from a math menu, journal entry, etc.)

There are a few limitations with the use of end-of-semester grades. First, four different teachers assigned the grades to their students, each utilizing non-standardized grading practices. Teacher One's tests might be more difficult than Teacher Two's tests, thus getting an "A" on a test in Teacher One's class is harder to achieve than in Teacher Two's class. In addition, all of the teachers used different assignments and perhaps even different weightings of assignments in deriving their grades. Thus, we cannot definitively state that an "A" for one student in one school is equivalent to an "A" for another student in a different school. A second limitation of using end-of-semester grades is that much of

the composition of the grades is formed by teacher-made assessments. Marso and Pigge (1991) found that 72% of the items analyzed in their study of teacher-made tests were at the knowledge level (math tests, however, did have the highest level of test items beyond the knowledge level; 47% of problem-based, application items were found on math tests). Though this is an old study, not much has changed. Test items in teacher-made assessments [still] tend to focus on lower cognitive levels (Notar, Zuelke, Wilson, & Yunker, 2004). This prevalence of knowledge-level test items raises the issue of validity in teacher-made tests. Validity is defined as “the extent to which inferences drawn from assessment results are appropriate,” (Gareis & Grant, 2008, p. 194). What can we safely infer about a student’s mathematical ability based on end-of-semester grades that at most could be partially comprised of computation and application problems found on teacher-made assessments?

Despite these limitations to using teacher-assigned grades, it is important to include them as a variable because students are often concerned with grades and see them as important (Gareis & Grant, 2008). However, in order to get a more balanced picture of each student’s math ability, and to address the non-standardization and validity issues of teacher-assigned grades, this study included the TOMAGS (a norm-referenced mathematics achievement test) as an achievement variable in addition to end-of-semester math grades derived from teacher-assigned grades.

### **Research Design**

This research study employed a basic descriptive design. As an exploratory study, its main goals were to describe the variables being studied and to determine if relationships existed between them in order to inform future research and interventions.

The study also endeavored to discover if any group comparison differences existed in the variables based on gender. The independent variable studied was the gender of the high-ability math students. The dependent variables studied were math motivation (operationalized as a CAIMI Math score), math achievement (operationalized as an end-of-semester math grade and a TOMAGS score), and goal orientation (operationalized as a “learning goal orientation” or a “performance goal orientation” based on the two CAIMI math questions that address goal orientation) of the students. This design, by nature, was very simple; it involved collecting the data needed and performing the analyses necessary for the research questions. It used ANOVA tests to determine differences of means for math achievement and math motivation based on gender and goal orientation, a Chi Square Test of Independence to analyze frequencies for goal orientation, and a correlational analysis to determine relationships. Because this study was not experimental, there was no need to address internal or external validity. However, teacher training for the administration of the CAIMI was important to ensure fidelity of implementation of the tool.

### **Procedures for Data Collection**

A portion of data used in this study was obtained through a field research project (FRP) in the Spring of 2013. Additional cases were collected in early March of 2014. Educational Institutional Review Committee (EDIRC) approval through the Human Subjects Committee at the College of William and Mary was obtained for the sample on March 14, 2013. School division research approval for the FRP was also granted. The data collected for the FRP that was used for the current study were: gender, race,

TOMAGS scores (scaled scores and percentile scores), end-of-semester grades, CAIMI Math scores, and goal orientation. Several steps were followed to collect the data:

**Step 1: Teachers recruited.** Four elementary schools were used in the FRP, and one 5<sup>th</sup> grade teacher who was teaching 6<sup>th</sup> grade math from each school agreed to participate in April of 2013 (one teacher was the current researcher). In March of 2014, three of the same teachers in the same schools were recruited again to collect more of the same data with their current high-ability math students. A new teacher at the fourth elementary school was also recruited to replace the current researcher, thus five teachers total participated in this research study.

**Step 2: Teachers trained on the data collection.** Teachers received a Data Collection Chart (see Appendix), copies of the Consent Letter for their students, and a copy of directions for administering the CAIMI from the CAIMI Examiner's Manual. Through e-mail and phone conversations, teachers' questions regarding administration, if any, were answered.

**Step 3: Data collected.** When all consent letters were returned, the teachers administered the CAIMI during a one-hour class period. Concurrently, the teachers used their student records to enter the additional data into the Data Collection Chart. CAIMIs and Data Collection Charts were collected by the researcher upon completion.

### **Procedures for Data Analysis**

As previously stated, this study was an exploratory study of math motivation and its relationship to math achievement, goal orientation, and gender for high-ability math students. Although the CAIMI can produce scores in five different areas (Reading, Math, Science, Social Studies, and General Motivation), only the Math score was used in this

study. Basic descriptive statistics (means and standard deviations), ANOVA ( $\alpha < .05$  significance), Chi Square Test of Independence, and Pearson  $r$  product-moment correlation statistics (with correlations ranging from -1.00 to +1.00) were used to analyze the research questions. All statistical analyses were performed by using IBM SPSS Statistics Version 22 software. See Table 2 for a description of each research question, the statistic(s) that will be used to answer it, and the source(s) of data for each analysis.

Table 2

*Research Questions, Statistics, and Sources of Data*

<b>Research Question</b>	<b>Statistic(s) Used to Answer It</b>	<b>Source(s) of Data</b>
What is the math motivation level of high-ability math students?	Mean and Standard Deviation to describe math motivation levels by whole group and by gender; ANOVA to compare mean differences between genders	CAIMI math motivation score
What is the math achievement of high-ability math students?	Mean and Standard Deviation to describe math achievement levels by whole group and by gender; ANOVA to compare mean differences between genders	TOMAGS Teacher grade
What is the goal orientation of high-ability math students?	Chi Square Test of Independence to analyze frequencies of goal orientation types	CAIMI questions 25 and 26
To what degree is the math motivation of high-ability math students related to their math achievement?	Pearson $r$ product-moment correlation to show the nature of any relationship between math motivation and math achievement	CAIMI math motivation score; TOMAGS; Teacher grade
What is the math achievement level of high-ability math students based on their goal orientation?	Mean and Standard Deviation to describe math achievement levels by goal orientation; ANOVA to compare mean differences between goal orientations	TOMAGS; Teacher grade; CAIMI questions 25 and 26
What is the math motivation level of high-ability math students based on their goal orientation?	Mean and Standard Deviation to describe math motivation levels by goal orientation; ANOVA to compare mean differences between goal orientations	CAIMI math motivation score; CAIMI questions 25 and 26

## Chapter 4

### Results

In order to investigate math motivation levels, math achievement, and goal orientations of 5<sup>th</sup> grade high-ability math students, various pieces of data were collected on 106 students. However, several cases had to be removed from the sample set. Two cases had significantly incomplete data and were omitted from the set. Seven other cases were found to be outliers after conducting a boxplot analysis of CAIMI math motivation scores and were also omitted.<sup>1</sup> Two cases had one piece of missing data from their CAIMI math scores that was replaced by using a series mean. Thus, the final sample for analysis included 97 students— 44 were female (45.4%), 53 were male (54.6%), 8 were Asian (8.2%), 2 were Black (2.1%), 8 were Multi-Racial (8.2%), and 79 were White (81.4%). Due to the small numbers of Asian, Black, and Multi-Racial students, analyses were not conducted by race because small samples will not provide statistically accurate results nor allow for meaningful comparisons.

#### **Research Question 1: What is the math motivation level of high-ability math students?**

The entire CAIMI was administered to all students in the sample, however only the math subscale was used for analysis in order to determine the students' math motivation level. Items asked students to rate many things about math, such as their enjoyment of it, persistence in it, and commitment to new tasks, for example (Gottfried, 1986a). The CAIMI math scores ranged from 26 to 124; higher scores correspond to higher motivation levels and lower scores correspond to lower motivation levels

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<sup>1</sup> All statistical analyses for this study were computed using IBM SPSS Statistics Version 22.

(Gottfried, 1985). For the 97 students included in this analysis, the mean score was 102.44 ( $SD=12.35$ ). For the 44 girls in the study, the mean was 102.23 ( $SD=11.91$ ). For the 53 boys, the mean was 102.60 ( $SD=12.81$ ). The kurtosis of these scores was in the normal range for each group (total students, females, and males), but the scores were negatively skewed for all three groups. Negative skewness means that the majority of scores were at the positive end of the score distribution, showing that there were a larger number of higher scores (George & Mallery, 2012). Negative skewness could affect the mean of these scores, but the ANOVA is robust even with marginally non-normal data (see Table 3).

Table 3

*CAIMI Math Scores, TOMAGS Scores, and Math Grades of 5<sup>th</sup> Grade High-Ability Math Students*

Group	<i>M</i>	<i>SD</i>	Range	
			Minimum	Maximum
Female ( <i>n</i> =44)				
CAIMI Math	102.23	11.91	66	119
TOMAGS	129.16	8.39	115	148
Math Grades	91.48	3.75	82	100
Male ( <i>n</i> =53)				
CAIMI Math	102.60	12.81	66	123
TOMAGS	130.66	9.96	104	148
Math Grades	91.51	3.64	80	97
Total ( <i>n</i> =97)				
CAIMI Math	102.44	12.35	66	123
TOMAGS	129.98	9.27	104	148
Math Grades	91.49	3.67	80	100

To determine if the difference between the mean CAIMI Math scores for boys and girls was statistically significant, a one-way analysis of variance (ANOVA) was performed. The one-way ANOVA indicated no significance between CAIMI Math mean

scores for girls and boys,  $F(1,95) = .022, p > .05$ . Thus, CAIMI Math scores for girls and boys were not statistically significantly different.

**Research Question 2: What is the math achievement level of high-ability math students?**

Two types of math achievement data were collected for the subjects in this study— quotient scores from a nationally normed standardized math test (the TOMAGS) and teacher-assigned, first semester math grades. Students could earn up to 47 points for a raw score on the Intermediate TOMAGS. By using the norming tables in the Examiner’s Manual, raw scores were converted to quotients that correspond to a range of 54 to >148 (Ryser & Johnsen, 1998). The mean TOMAGS quotient scores for the entire group of 97 students was 129.98 ( $SD=9.27$ ), for girls it was 129.16 ( $SD=8.39$ ), and for boys it was 130.66 ( $SD=9.96$ ). Math grades ranged from 0-100 points. The mean math grade for the group was 91.49 ( $SD=3.67$ ). Girls had a mean math grade of 91.48 ( $SD=3.75$ ) and boys had a mean math grade of 91.51 ( $SD=3.64$ ). The mean math grades for all students translated into an “A” on the 10-point grading scale. The means for all three groups (total, female, and male) had skewness and kurtosis in the normal range, thus suggesting all of the achievement scores for this sample were within an acceptable distribution (see Table 3).

A one-way ANOVA was performed on both math achievement measures in order to determine if the differences between mean scores for girls and boys were statistically significant. The one-way ANOVA indicated no significance between TOMAGS mean scores for girls and boys,  $F(1,95) = .0629, p > .05$  or between math grades for girls and

boys  $F(1,95) = .002, p > .05$ . Thus, the differences between math achievement measures for girls and boys were not statistically significant.

**Research Question 3: What is the goal orientation of high-ability math students?**

The last two questions of the CAIMI math subscale provided the Goal Orientation data for this study. The first question was designed to identify if students valued math tasks more for learning or a grade and the second question endeavored to determine if students preferred repeating work over or learning new concepts. There were three possible scores a student could receive on these questions— 2, 3, or 4. Students who received a score of “2” ( $n=6$ ) or “3” ( $n=51$ ) were coded as holding a performance goal orientation; students who received a “4” ( $n= 40$ ) were coded as holding a learning goal orientation. A Chi Square Test of Independence was conducted on the Goal Orientation data. The Crosstabulation showed the frequencies for gender and goal orientation (see Table 4). Of the 97 students, 40 had a learning goal orientation (41.2%) and 57 had a performance goal orientation (58.8%). Of the 44 girls, 17 had a learning goal orientation (38.6%) and 27 had a performance goal orientation (61.4%). Of the 53 boys, 23 had a learning goal orientation (43.4%) and 30 had a performance goal orientation (56.6%; see Table 4). The differences for these frequencies was not statistically significant,  $\chi^2(1, N=97) = 0.635, p > .05$ . Thus, neither girls nor boys were more likely to hold one goal orientation over another.

Table 4

*Frequencies of Gender and Goal Orientation for 5<sup>th</sup> Grade High-Ability Math Students*

	Goal Orientation	
	Learning	Performance
Female	17 (38.6%)	27 (61.4%)
Male	23 (43.4%)	30 (56.6%)
Total	40 (41.2%)	57 (58.8%)

**Research Question 4: To what degree is the math motivation level of high-ability math students related to their math achievement?**

To determine if there was a relationship between math motivation levels and math achievement in high-ability math students, the Pearson Correlation statistic was used to analyze CAIMI Math scores, TOMAGS scores, and Math Grades. George & Mallery (2012) report that even though the Pearson Correlation statistic operates under the assumption that the data used with it is normally distributed, it still works well with data that violates this assumption, such as the negatively skewed CAIMI Math scores of this study's population. The Pearson Correlation showed that there was no correlation between CAIMI Math scores and TOMAGS scores, nor between CAIMI Math scores and Math Grades. There was, however, a weak positive correlation between TOMAGS scores and Math Grades,  $r(95) = +.35$ ,  $p < .01$ ,  $r^2 = .12$ , though this finding is not germane to the present study (see Table 5 for all correlations). A visual inspection of the scatterplots from the correlations confirmed that there is no relationship between CAIMI Math scores and either math achievement variable (see Figures 1 and 2) and a weak positive correlation between TOMAGS scores and Math Grades (see Figure 3). Thus, math motivation scores are not correlated with math achievement scores in this investigation.

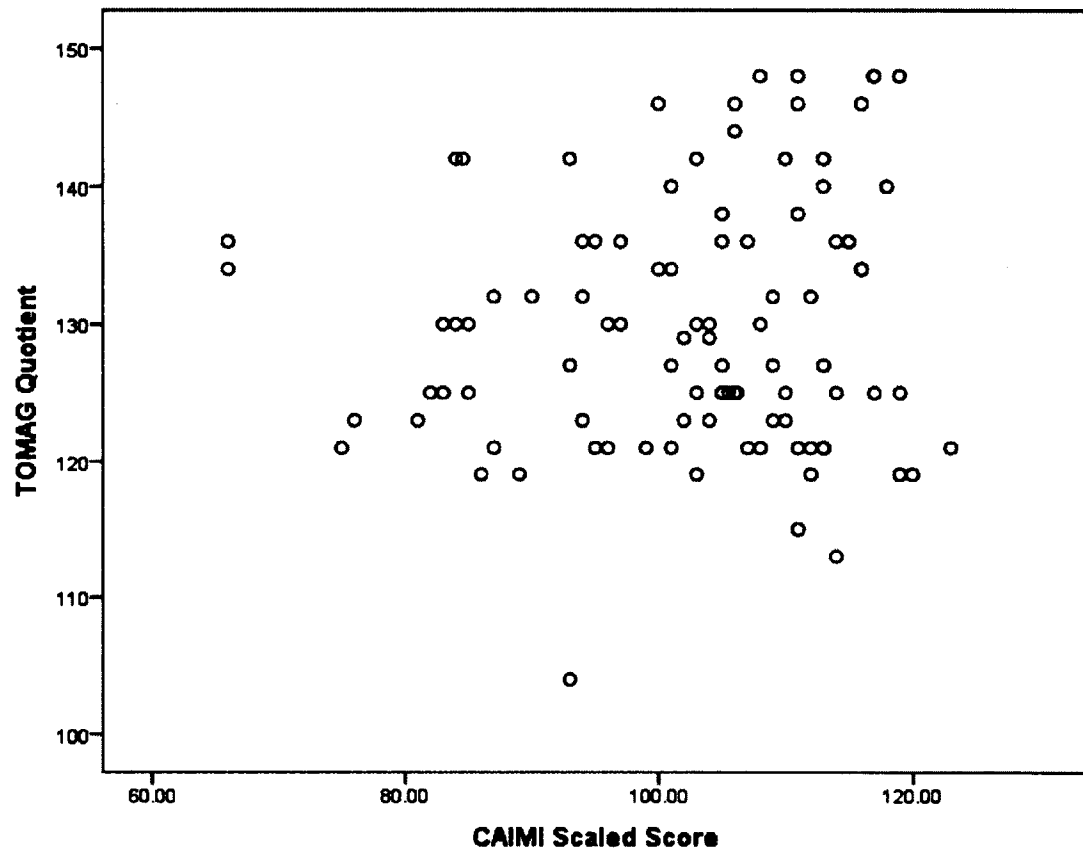
Table 5

*Correlations of CAIMI Math Scores and Math Achievement Measures of 5<sup>th</sup> Grade High-Ability Math Students*

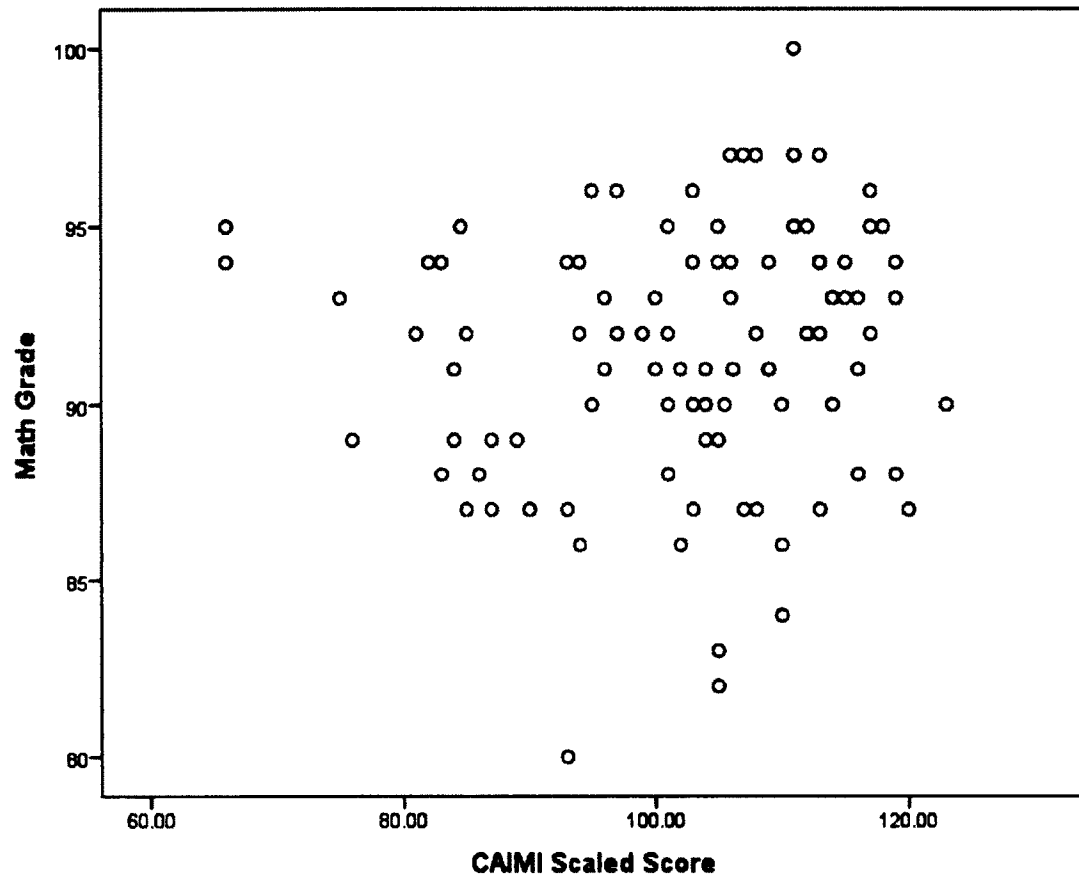
	CAIMI Math	TOMAGS	Math Grades
CAIMI Math	--		
TOMAGS	.112	--	
Math Grades	.120	.351**	--

*Note.*  $N = 97$

\*\* . Correlation is significant at the 0.01 level (2-tailed).

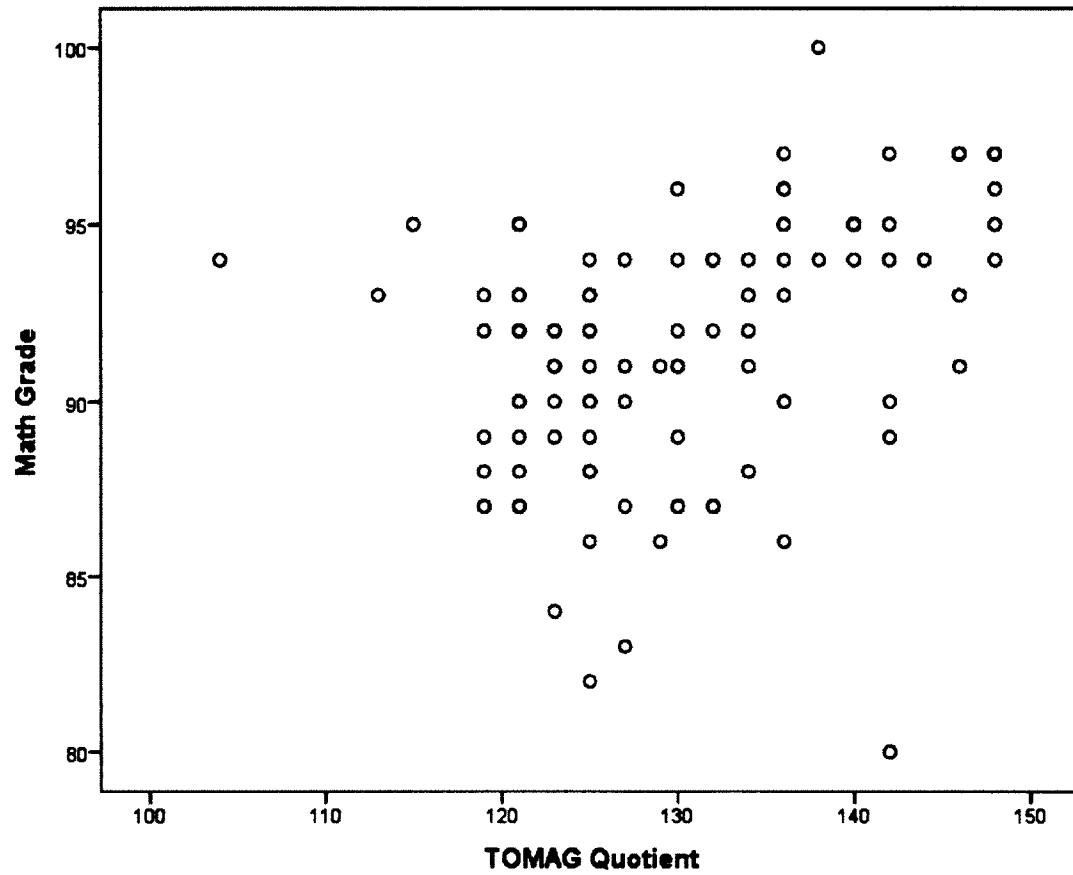


*Figure 1.* Scatterplot of high-ability math students' standardized math achievement scores and motivation scores. No relationship was found between these two variables. Each dot on the scatterplot represents a student in the sample.



*Figure 2.* Scatterplot of high-ability math students' math grades and motivation scores.

No relationship was found between these two variables. Each dot on the scatterplot represents a student in the sample.



*Figure 3.* Scatterplot of high-ability math students' math grades and TOMAGS scores. A weak positive correlation was found between these two math achievement measures. Each dot on the scatterplot represents a student in the sample.

**Research Question 5: What is the math achievement level of high-ability math students for each goal orientation?**

Math achievement scores for the sample were analyzed based on students' goal orientation (see Table 6). To determine if the difference between the mean math achievement scores for different goal orientations was statistically significant, a one-way ANOVA was performed. Results indicated no significance between either TOMAGS mean scores,  $F(1,95) = .094, p > .05$  or math grades,  $F(1,95) = 2.56, p > .05$  by goal orientation. Thus, math achievement scores for either goal orientation were not significantly different.

Table 6

*CAIMI Math Scores, TOMAGS Scores, and Math Grades for each Goal Orientation of 5<sup>th</sup> Grade High-Ability Math Students*

Group	<i>M</i>	<i>SD</i>	Range	
			Minimum	Maximum
<b>Learning (<i>n</i>=40)</b>				
CAIMI Math	106.02	10.01	82	120
TOMAGS	130.33	9.79	104	148
Math Grades	92.20	3.49	82	97
<b>Performance (<i>n</i>=57)</b>				
CAIMI Math	99.92	13.26	66	123
TOMAGS	129.74	8.96	113	148
Math Grades	91.00	3.74	80	100
<b>Total (<i>n</i>=97)</b>				
CAIMI Math	102.44	12.35	66	123
TOMAGS	129.98	9.27	104	148
Math Grades	91.49	3.67	80	100

**Research Question 6: What is the math motivation level of high-ability math students for each goal orientation?**

CAIMI scores for each goal orientation were analyzed for the sample (see Table 6). To determine if the difference between the mean CAIMI Math scores for students with a learning goal orientation and students with a performance goal orientation was statistically significant, a one-way ANOVA was performed. The results indicated significance between CAIMI Math mean scores for learning goal orientation and performance goal orientation,  $F(1,95) = 6.028, p < .05$ . Thus, the two goal orientations had statistically different mean math motivation levels.

**Summary of Results**

Six research questions concerning 5<sup>th</sup> grade high-ability math students were analyzed for the current study. In regard to math motivation, students in the sample had a mean motivation score of 102.44. As for math achievement, the mean TOMAGS score was 129.98 and the mean grade for the sample was a 91.49, "A." In addition, differences in means for achievement and motivation were not significant by gender and math motivation and math achievement were not correlated in this sample.

In regard to goal orientation, more students held a performance goal orientation, though differences between the two orientations were not significant for the total sample nor by gender. In addition, students of both goal orientations had similar math achievement scores, though the differences in the math achievement means between the two goal orientations were not significant. However, the two goal orientation groups had significantly different motivation levels. Students holding a learning goal orientation had

a significantly higher math motivation level than students holding a performance goal orientation.

In sum, the results of the analyses indicated that:

- girls and boys had no statistical differences for math motivation or math achievement (Research Questions 1-2);
- girls and boys were equally likely to hold either a learning goal orientation or a performance goal orientation (Research Question 3);
- there was no significant relationship between math motivation and math achievement (Research Question 4);
- there was no significant difference between mean math achievement scores for learning and performance goal orientations (Research Question 5); and
- students holding a learning goal orientation had significantly higher math motivation scores than students holding a performance goal orientation (Research Question 6).

## **Chapter 5**

### **Conclusions**

The purpose of this exploratory study was to investigate math motivation levels, math achievement, and goal orientations of 5<sup>th</sup> grade high-ability math students of both genders. It was timely to delve into these issues for several reasons: there is a call in the field of gifted education to learn more about motivation and giftedness; talent development models of gifted education support the identification of and services for talent at young ages; and there is national interest, both politically and educationally, to increase retention of bright boys and girls in the STEM pipeline.

The first section of the discussion addresses the results of the research questions and then addresses gender. This section will be followed by the limitations of the study, implications of the findings, future research, and the summary and conclusions.

### **Discussion of Findings**

#### **Math Motivation**

The CAIMI was administered to the high-ability math students in this study and the math subscale was analyzed as a measure of their math motivation. Their mean math motivation score was 102.44, with individual scores ranging from 66 to 123 (see Table 3). The mean score is equivalent to the 48<sup>th</sup> percentile in the CAIMI norming tables (Gottfried, 1986b), which is not a statistically high motivation score. This score was surprising; one might expect a higher motivation score for high-ability math students who are participating in an accelerated math class due to their math talent. However, there is a precedent for this level of math motivation. Gottfried and Gottfried (1996) conducted a comparison analysis of gifted and non-gifted students from the Fullerton Longitudinal

Study. They designated students who had an IQ score of 130 or higher at age 8 as gifted. Using this criterion, 20 students from the sample were included in the gifted group and 79 were not. The CAIMI scores for the 99 students were analyzed at age 9, 10, and 13. At all three ages, the gifted group had statistically significantly higher scores in each subscale than the non-gifted group. When looking specifically at math, the gifted group had a mean CAIMI math score of 100.85—47<sup>th</sup> percentile—at age 10 (roughly the same age that the students in the present study were when their CAIMI Math scores were collected) compared to a mean score of 91.07—26<sup>th</sup> percentile—for the non-gifted group. The mean score of 100.85 for Gottfried and Gottfried’s gifted group is similar to the mean score of 102.44 for the high-ability math students in the present study. It is possible that a math subscale score of 102 in the current study, though lower than expected, is a typical math motivation score for gifted and high-ability students.

### **Goal Orientation**

The last two questions from the CAIMI math subscale were the source of the goal orientation data for this study. Despite the uneven proportions of goal orientations among the high-ability math students (57 held a performance goal orientation and only 40 held a learning goal orientation), results did not show that these frequencies were statistically, significantly different.

It was not surprising that more 5th graders in this study held a performance goal orientation than a learning goal orientation. Research on goal orientation theory has indicated that most young children were believers in the incremental theory of intelligence (Dweck & Leggett, 1988) and could be predicted to have a mastery [or learning] goal orientation (Bong, 2009). Schwinger & Wild (2011) found in their

longitudinal study of goal orientation profiles of 302 German students over the course of 3<sup>rd</sup> through 7<sup>th</sup> grade, most students switched from a mastery goal orientation to a more performance-oriented one between the 4<sup>th</sup> and 6<sup>th</sup> grades. Part of the explanation for this switch is developmental. Around age 10, children begin to compare themselves to their peers in order to judge their own competence (Ruble, Boggiano, Feldman, & Loebel, 1980). Social comparison is a necessary element of holding a performance goal orientation (Bong, 2009), and at age 10, children have the cognitive ability to engage in comparison for self-evaluation (Harter, 1998). Due to 5<sup>th</sup> graders' developmental ability to participate in social comparison, in combination with the high-stakes nature of the accelerated math class (students had to maintain a "B" or better to remain in the high-ability math class), it is not surprising that the majority of students in the current study held a performance goal orientation. Most likely, it was important to them to earn a good grade in the class, even at the expense of learning math for the enjoyment of it.

### **Math Achievement and Math Motivation**

To determine if math achievement and math motivation of these high-ability 5<sup>th</sup> graders was related, both teacher-assigned math grades for the end-of-semester and standardized TOMAGS scores were analyzed with CAIMI Math scores. Both the mean math grade and the mean TOMAGS score were expected due to the nature of the students in the math class (high math grades were anticipated from advanced math students, plus the criteria to be included in the class required that students had a TOMAGS profile of 92<sup>nd</sup> percentile— 121— or higher, with very few exceptions). However, unexpectedly, there was no correlation between either measure of math achievement and math motivation in this study. This was an unanticipated outcome because Gottfried (1985)

had reported a significant relationship between academic intrinsic motivation and achievement, in general, as well as between the math motivation subscale of the CAIMI and math achievement, specifically, during her development of the CAIMI.

Posey (1989) suggested caution when drawing conclusions from CAIMI results that do not replicate the conclusions from Gottfried's original study (for example, her conclusion regarding the strong relationship between the CAIMI math subscale and math achievement). In light of Posey's suggestion, there is a possible explanation for a finding of no correlation in the current study. The Pearson  $r$  correlation coefficient can be limited by four factors

(<http://www.gifted.uconn.edu/siegle/research/correlation/correlation%20notes.htm>):

1. Nonlinear relationships (possibly a concern in this study because the results of the current study showed no relationship between the variables, and “no relationship” is a nonlinear relationship);
2. Unreliable instrument (not a concern in this study because the CAIMI has strong reliability);
3. Homogeneous groups, meaning the subjects are quite alike on the variables (possibly true in this study due to the academic profile of students in the class, but both achievement measures seemed to have enough variability— for teacher-assigned grades, the range was 80-100 and for the TOMAGS it was 104-148); and
4. The ceiling effect, meaning scores grouped together at either the top or bottom of the range, with little variability (this factor is similar to the homogeneous groups factor, so the ceiling effect could also be a factor in this study).

Thus, it is conceivable that the factors of a nonlinear relationship, homogeneous groups, and the ceiling effect limited the Pearson  $r$  correlation coefficient in this investigation, explaining why there was no correlation between math achievement and math motivation. In addition, there are two possible reasons to explicate the low math motivation scores in the current study (which was also unexpected, because achievement was high): (1) lack of optimal challenge, and (2) a decline in math motivation.

**Optimal challenge.** In her validation of the Y-CAIMI, Gottfried (1990) addressed a potential phenomenon with students who have a high IQ. She said it is possible that they might have lower intrinsic motivation than children of average intelligence due to the fact that they might not be adequately challenged in school. She connected this possible lack of adequate challenge to Deci and Ryan's (1985) concept of *optimal challenge*. Deci and Ryan described their concept as such:

When people are free from the intrusion of drives and emotions, they seek situations that interest them and require the use of their creativity and resourcefulness. They seek challenges that are suited to their competencies, ones that are neither too easy nor too difficult. When they find optimal challenges, people work to conquer them, and they do so persistently. In short, the needs for competence and self-determination keep people involved in ongoing cycles of seeking and conquering optimal challenges. (p. 33)

They further stated that, in order for a person to increase intrinsic motivation for an activity, the activity must provide optimal challenge to the person. Tasks that are too easy or too hard will lead to either boredom or stress, neither of which contributes to the development of intrinsic motivation.

Presumably, Gottfried was speculating that high-ability students might not receive adequate— or optimal— challenge in the classroom, thus they would be bored with tasks and activities that were too easy for them and display lower intrinsic motivation than their average-ability peers because of it. This phenomenon could explain why high-ability students might have high achievement yet low motivation. Though an intriguing explanation, Gottfried's application of it does not quite fit the students' circumstances in the current investigation. Gottfried and Gottfried's 1996 analyses indicated that gifted students had higher math CAIMI scores than their non-gifted peers at ages 9, 10, and 13. In addition, the high-ability 5<sup>th</sup> grade math students in this study are theoretically in an optimally challenging educational situation. They were identified at a young age for their math talent and placed in a homogeneously grouped, accelerated math class, learning a 6<sup>th</sup> grade math curriculum as 5<sup>th</sup> graders in order to address their advanced mathematical needs. It is unlikely that the math tasks in their math class were too easy; rather, it is more likely that the activities were too hard, thus leading to stress for the students and decreased math motivation.

**Decline in math motivation.** There is much research about the decline of math motivation among students through the years, though most of it is in regard to middle and high school. There are some studies for middle and elementary school, though. Pajares and Graham (1999) studied change in math motivation and performance during the first year of middle school (grade 6) for 273 gifted and non-gifted students from the Southern region of the U.S. (though they did not investigate the causes of the changes). They found that the gifted students tended to have higher math performance scores and stronger, more accurate, and less over-confident self-efficacy beliefs in math than non-gifted

students. However, when looking at gifted and non-gifted students together as a whole, students saw math as less valuable by the end of the year and they had lower persistence and effort in math by the end of the year. In addition, overall, students' self-efficacy beliefs in math predicted math performance at the beginning and at the end of the 6<sup>th</sup> grade year. Though causal information for math decline was not the scope of Pajares and Graham's work, they did document the decline in math motivation in 6<sup>th</sup> grade students as well as the areas of decline (value, persistence, and effort).

Several studies have indicated that a decline in math motivation begins in the elementary school years. Gottfried, Fleming, and Gottfried (2001) and Gottfried, Marcoulides, Gottfried, Oliver, and Guerin (2007) showed that math motivation began to decline in late elementary school. More recently, Metallidou and Vlachou (2010) studied the self-regulated learning profiles of 263 Greek 5<sup>th</sup> and 6<sup>th</sup> grade students who had high and low task-value beliefs in math and reading. They reported that motivation, operationalized as task-value belief, declined over the course of the elementary years. In light of this research on a motivational decline in math from the elementary school years through 6<sup>th</sup> grade, it is possible that the high-ability math students in the current study are undergoing a decline in math motivation. Based on research conducted at the middle and high school levels, there are several sources of this decline, all of which can apply to the high-ability, accelerated math students in the current study, as well.

*Anxiety.* In one analysis of CAIMI scores of 96 students from the Fullerton Longitudinal Study at ages 9, 10, 13, 16, and 17, Gottfried, Fleming, and Gottfried (2001) reported the largest decline in motivation to be in math. They discussed possible reasons for the decline to be anxiety due to worries over grades, school activities, and college

preparatory work as students progressed through middle and high school. They also cited research that math is perceived as being hard and students might not feel they have the ability to do well in math. They postulated that perhaps only students with the highest levels of intrinsic motivation could handle higher levels of math (Gottfried, Fleming, & Gottfried, 2001). As previously mentioned, students must keep a “B” average or higher in their math class in order to remain in it, thus grades are likely a source of stress for students in the current study. In addition, the challenging nature of the accelerated course might also cause some of the high-ability students to feel weaker in math than in the past, especially because math probably had been one of their best subjects in the regular classroom.

***Parent and teacher pressure.*** Parents and teachers can inadvertently pressure their students, creating anxiety, which can subsequently lead to a decline in motivation. Gottfried, Marcoulides, Gottfried, and Oliver conducted an analysis of parental motivational practices on the Fullerton group in 2009. They defined two types of parental involvement practices: *task intrinsic*— such as encouragement of children’s curiosity, task involvement, persistence, and pleasure in learning, and *task extrinsic*— such as implementing consequences and giving rewards that were based on students’ performance. They found that students whose parents used task intrinsic behaviors had less of a decline in math than did students whose parents used task extrinsic behaviors. Further, parent use of task intrinsic behaviors was a significant predictor of academic intrinsic motivation through students’ schooling. Another study of parent practices used the framework of self-determination theory. Garn & Jolly (2014) conducted a qualitative study of intrinsic motivation of 15 gifted 3<sup>rd</sup>-8<sup>th</sup> graders in a summer program for gifted

students. They found that these students were more highly motivated by parents and teachers who tapped into their learning interests and goals and offered choices to students in what they could learn. Parental pressure for high grades and punishment for low grades created anxiety in the gifted students and decreased their intrinsic motivation. However, the students liked getting rewards for high grades, though this form of external control is not considered to be a contributor to intrinsic motivation. It is possible that the students in the advanced math class in the current investigation are feeling anxiety from their parents and teachers, which could be impacting their math motivation.

*Low math achievement.* Gottfried (1990) had found that early math achievement was related to later motivation and that it predicted math motivation at age 9. In addition, in that same analysis, she found that motivation was an independent and significant predictor of achievement, but concluded that “achievement appears to be a more consistent predictor of motivation than the reverse,” (p. 537). In 2007, Gottfried, Marcoulides, Gottfried, Oliver, and Guerin, applied latent change modeling to CAIMI Math scores and math achievement scores of the 114 students from the Fullerton Longitudinal group from age 9 through age 17. They found that both variables declined with age until about age 16, and that “math achievement is a significant contributor to the developmental decrease in intrinsic math motivation from childhood through adolescence,” (p. 325). Thus, math achievement affects future math achievement as well as future math motivation in students. In this study, the students’ TOMAGS score is a stable variable and would not show decline because it was a one-time snapshot of gifted-level math achievement. However, teacher-assigned grades are not stable. Though the students in

this study were not experiencing low math achievement according to traditional grading standards, their mean math grade of a “92” was theoretically lower than what they had received in 4<sup>th</sup> grade in the regular math classroom. Furthermore, students had to work harder in the accelerated class to earn their “A” averages because the content was a grade level ahead of where it should be based on their chronological age. Consequently, it is possible that these high-ability students *were* displaying a decrease in math achievement as well as a decline in motivation due to lower math achievement.

**Conclusions.** According to the research on optimal challenge, students are most motivated when tasks are not too challenging and not too easy, but are just right (this is known as the *Goldilocks Principle* in cognitive science; Graesser, 2009). Theoretically, the students in this study were taking an appropriately challenging, accelerated math class designed to meet their demonstrated math talent needs. Academically, the students in the math class were achieving at an expectedly high level of a 92, “A.” At a 102, the math motivation level for these high-ability students is on par with prior math CAIMI subscale research for gifted/high-ability math students. However, their math achievement level and their math motivation level are not correlated as expected based on the validation studies by Gottfried (1985).

A confluence of reasons can explain why math motivation is low and math achievement is high in this study (another unexpected finding). It is possible that the accelerated math class borders on the “too hard” side of the optimal challenge theory. It is a middle school course being taught at the elementary school and is replete with new concepts and new content that in many cases pose new, harder challenges to the students. These challenges might be causing the students to earn lower math grades than typical for

high-ability math students who would traditionally be in a regular, on-grade-level math class with non-gifted students. Furthermore, the math class has a high-stakes nature to it, which can create pressure and anxiety in the students, thus contributing to a decline in math motivation. Students must maintain a “B” average or higher in order to continue in the class because it is the gateway course to an accelerated math pathway in this school division. Parents and teachers are also mindful of the students’ performance. Based on conversations with the teachers in this study, parents receive weekly communication from the teachers about student performance. This type of external pressure from teachers and parents could cause additional anxiety in many students, and might have led to dampened motivation in these math classes. Lastly, the semester math grades ranged from 80-100 with a mean of 92. Through talking with the teachers, many of the students in the study came from math backgrounds of high “A’s” on all of their math work, with no studying, hence the grades they are earning in the accelerated, 6<sup>th</sup> grade math class are likely lower than that to which they are accustomed. It is reasonable to conclude that the conditions described above might be creating the decline in math motivation of the students in this study that is typically seen in late elementary to early middle school even though their achievement is high.

### **Goal Orientation and Math Achievement**

Prior research on goal orientation and math achievement has indicated several interesting findings, such as: holding a learning goal orientation was a significant and consistent predictor of general academic as well as math achievement, non-academic achievement (i.e., music, etc.), and leadership/social achievement (Chan, 2008; Keys, Conley, Duncan, & Domina, 2011); a learning goal orientation was positively, though

mildly, correlated with math achievement (Keys, Conley, Duncan, & Domina, 2012); a mastery-approach goal correlated positively with math performance at the 3<sup>rd</sup> and 4<sup>th</sup> grade levels and a performance-approach goal significantly and positively correlated with math performance at grades 5 and 6 (Bong, 2009); and a performance-avoidance goal orientation was negatively correlated with math achievement, with lower math achievement predicting a performance-avoidance goal orientation (Mägi, Lerkkanen, Poikkeus, Rasku-Puttonen, & Kikas, 2010). This body of literature generally suggests that students with a learning goal orientation have higher math achievement than students with a performance goal orientation, that more students in grades 5-6 hold performance goal orientations than at grades 3-4, and that lower math achievement tends to predict a performance goal orientation. In the current study, more of the 5<sup>th</sup> grade students held a performance goal orientation, as observed in prior research. However, there were no statistically significant differences in mean achievement scores for either goal orientation; both groups had high math achievement. Thus, the behavior of this sample did not fully support prior research findings with regard to math achievement and goal orientation.

### **Goal Orientation and Math Motivation**

Findings in this study indicated that students holding a learning goal orientation had significantly higher math motivation scores than students holding a performance goal orientation. No prior research could be located on the relationship between math motivation and goal orientation, specifically, but there is general research on intrinsic motivation and achievement goals.

In 1998, Mueller and Dweck carried out six studies, each with groups of 5<sup>th</sup> grade students, using tasks of varying difficulty levels to determine the students' response to

praise, their response to failure, and their goal orientation. Overwhelmingly, students who held performance goals had large drops in intrinsic motivation in the face of failure, but students with learning goals had higher intrinsic motivation even if they experienced failure.

Additional research in the field provides more insight into the connection between intrinsic motivation and achievement goals. A meta-analysis of 23 experimental studies on achievement goals and intrinsic motivation found that performance goals undermined intrinsic motivation (Rawsthorne & Elliot, 1999), thus students holding performance goals had lower intrinsic motivation. Also in 1999, Dweck suggested that learning goals appeared to “foster and sustain greater intrinsic motivation,” (p. 19). A recent study by Cerasoli and Ford (2014) supported Dweck’s observation and expanded on it. In their longitudinal study of 91 college students, they attempted to elucidate a causal link between intrinsic motivation and performance by exploring the role of mastery [learning] goals in the relationship. They found that mastery goals and intrinsic motivation had a reciprocal relationship. Not only did mastery goals lead to stronger intrinsic motivation, which led to strong performance (along the lines of Dweck’s findings), they also found that strong intrinsic motivation led to the adoption of mastery goals in order to increase competence and have stronger performance. Regardless, no matter which way students attain their mastery goals (either before or after their intrinsic motivation is piqued), strong intrinsic motivation is related to a learning goal orientation.

Taken together, this body of literature sheds light on the results of the present study. It is clear that a performance goal orientation is associated with lower intrinsic motivation, and vice versa. The results of the current study support these findings, as

well. When considering the nature of the accelerated math class and the challenges presented in it to the students in the sample, Mueller and Dweck's (1998) finding could explain *why* students with performance goals had lower math intrinsic motivation than students with learning goals did.

### **Gender**

There are mixed findings in the literature regarding gender, math achievement, and math motivation. Some researchers have noted no statistically significant differences by gender for math achievement or math motivation among girls and boys, in general ( $N=114$ ; Gottfried, Marcoulides, Gottfried, & Oliver, 2013) or among gifted girls and boys ( $N=273$ ; Pajares & Graham, 1999). On the other hand, Preckel, Goetz, Pekrun, and Kleine (2008), found that gifted girls and gifted boys had similar math grades ( $n=181$ ), but gifted girls had lower motivation and lower math literacy scores [standardized test scores] than gifted boys. In addition, Watt, Shapka, Morris, Durik, Keating, and Eccles (2012) found that high school girls in their Australian sample had lower intrinsic value than high school boys ( $N=358$ ). As for goal orientation and gender differences, Schwinger & Wild (2012) studied 302 German students and found that more girls than boys had a mastery [learning] goal orientation, and more boys than girls held a multiple-goals orientation [a mixture of goals]. Despite the mixed findings from prior research, it was not surprising to find that in the present study, boys and girls had similar mean scores for math motivation and math achievement, as well as no significant differences for goal orientation. These results can be attributed to the nature of the accelerated math course and the academic background of the high-ability students in the present study. Students were carefully selected to be a part of the class based on their math talent, but

participation in the class was voluntary. Thus, students of very similar math ability all wanted to be in this class and knew they had to do well in the class in order to stay in it.

### **Limitations**

This study does have two main limitations: the sample and teacher-assigned grades. With regard to the sample, it was one of convenience. Because of the geographical area from which it was drawn, there was very little racial or ethnic diversity in the sample. Therefore, the sample could be biased because students were selected based on their physical location to the researcher. Further, the lack of diversity in the sample led to another issue— it was impossible to conduct statistical analyses by race. A last concern with the sample was that generalizability from a sample of this size and homogeneity might be difficult.

With regard to teacher-assigned grades, it became apparent when reviewing the types of assignments that comprised the teachers' grades that there was no standardization or consistency of grading practices among the four teachers. Though overall, students had similar grades no matter which teacher they had, it is possible that the validity of their grades was not as strong due to the lack of standardization. A weaker validity of grades might impact the meaning of the findings in this study that were based on teacher-assigned grades, such as the mean achievement score for grades, and correlations between grades and mean CAIMI Math scores, and the correlation between grades and goal orientations. However, because grades for all students were consistently high, it is unlikely— though possible— that the analyses were affected by inconsistent grading practices.

### **Implications of the Study**

This study uncovered a number of interesting findings with regard to high-ability 5<sup>th</sup> grade math students on the cusp of the math talent development trajectory. Several of the discoveries have important implications related to them that educators should consider to best meet the needs of their talented math students.

#### **Low Math Motivation**

Though technically the math motivation scores in this study are not low compared to prior research of gifted math motivation (Gottfried & Gottfried, 1996), they are unexpectedly low for students who were identified for special math programming due to their math talent. It is possible that these students are already experiencing uncomfortable challenges, pressure, and/or an early decline in motivation because they are in a middle school course at the elementary level. Teachers of accelerated math students should be aware of the research on optimal challenge, decline of math motivation and math achievement, and the potential stress that teachers and parents might put on the students in order to monitor their classroom practices. Gottfried, Fleming, and Gottfried (2001) recommend that interventions for boosting academic intrinsic motivation should be administered early in students' school careers. Therefore, classroom counseling of students is warranted for these issues. Parent training on utilizing task-intrinsic behaviors might also be necessary (Gottfried, Marcoulides, Gottfried, & Oliver, 2009). Lastly, schools should create learning environments that are mastery-oriented in order to support math intrinsic motivation (Gottfried, Marcoulides, Gottfried, & Oliver, 2013), and teachers should provide scaffolding to students for difficult concepts.

## **Gender Profile**

Results of the present study indicated no significant gender differences for math motivation, math achievement, or goal orientation despite some prior research findings that girls had lower motivation and achievement than boys. It is promising news from this study that high-ability boys and girls still have similar math profiles at the beginning of the math talent development process. However, prior research does point out that girls start losing interest in math in the 6<sup>th</sup> grade (Blue & Gann, 2008). Furthermore, the U.S. Department of Education (2012) reports low numbers of girls and women in STEM coursework at the secondary level, STEM majors at the post-secondary level, and STEM fields in the workforce. Consequently, it is imperative for educators to provide counseling and support to girls who show talent in math at young ages in order to keep them in the STEM pipeline.

## **High Prevalence of Performance Goals**

A greater number of students in this study had a performance goal orientation than a learning goal orientation. Schwinger and Wild (2011) noted that students become performance-oriented between the 4<sup>th</sup> and 6<sup>th</sup> grades. Performance goals are associated with lower intrinsic motivation. It is a concern that so many students in this study hold performance goals, especially in light of Mueller & Dweck's research on intelligence praise (1998). Praising children's intelligence causes them to become performance-oriented and concerned with being smart and looking smart. They postulate that labeling a student as gifted [or as high-ability to participate in an accelerated math class] is a type of intelligence praise. They say,

... when children are so labeled, some may become overly concerned with justifying that label and less concerned with meeting challenges that enhance their skills. They may also begin to react more poorly to setbacks because they worry that mistakes, confusions, or failures mean that they do not deserve to be labeled as gifted. (p. 50)

The researchers suggest that teachers of the gifted teach students to be resilient by embracing challenges, testing out various strategies, and giving full effort in all they do.

### **Future Research**

To advance the present findings, more research on math motivation, math achievement, goal orientation, and the math talent development path should be conducted. Several lines of research are viable, such as:

- A replication of the current study with a larger, more geographically and more diverse sample to create better generalizability and reveal information about students of diversity;
- An intervention study for elementary-aged, high-ability math students with low math motivation in order to determine ways to increase math motivation in these students;
- An exploratory study of goal orientation and math achievement of young, high-ability math students using a “trichotomous framework” (Chan, 2008, p. 38) that focuses on a learning goal orientation and a partitioned performance goal orientation (performance-approach goals and performance-avoidance goals) in order to gain more specific information about students’ goal orientations and related achievement;

- A mixed-methods study that includes the collection of quantitative math achievement and math motivation data as well as qualitative data through interviews of students to uncover their thoughts and feelings about their math motivation, math achievement, and the types of goals they have adopted and of their parents to measure their desire for their children to be in the accelerated class; and
- A longitudinal study that follows the students from the current study for several years to determine patterns of math motivation, math achievement, goal orientation, and gender.

### **Summary and Conclusions**

In sum, the current study answers the call in the field of gifted education to study math motivation more deeply. By assessing the math achievement, math motivation, and goal orientation of high-ability 5<sup>th</sup> grade math students at the beginning of their math talent development pathway, several interesting findings were revealed for this sample, such as: high-ability boys and girls have similar profiles of math motivation, math achievement, and goal orientation; these students' math motivation scores were low though their math achievement was high; math motivation and math achievement was not correlated for this sample of students; and a large proportion of high-ability math students hold a performance goal orientation at the 5<sup>th</sup> grade level.

Motivation is an important construct in education. More research must be done on the motivational patterns of the gifted, especially with young students of high math ability at the beginning of the talent development process. Studies such as the current one and the ones suggested for future research will add to our knowledge base by filling in

the picture of math motivation, math achievement, goal orientation, and the math talent development process of high-ability and gifted students of both genders.



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