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# Investigating the Impact of Mastery Motivation on Twelfth-Grade Math Performance: A Gender-Modulated Analysis of NAEP Mathematics Assessment Scores

**MIRNA DIAB[1], MINGYUAN ZHANG[2*]**

[1, 2] College of Education and Human Services Central Michigan University, USA

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***Corresponding author:** MINGYUAN ZHANG

College of Education and Human Services Central Michigan University, USA

## Abstract

***Objective*** *– This study explores the relationship between mastery motivation and math performance among twelfth-grade students while investigating how gender moderates this relationship. Specifically, the study aims to analyze the impact of mastery goals, performance goals, and persistence in math on NAEP twelfth-grade mathematics assessment scores and examine how gender influences this relationship.*

***Methods*** *– Mastery motivation, measured by mastery goals, performance goals, and persistence, is the independent variable, while the dependent variable is the 2019 NAEP Mathematics Assessment scores for Grade 12 students. The study also investigates the interaction between mastery motivation and gender as a moderator variable. Data was collected through the NAEP background questionnaire, and data analysis was performed using the NAEP Data Explorer, including descriptive tables, t-tests, and Cohen's d-effect sizes.*

***Results*** *– The study found that industry professionals and employers value micro-credentials to address the skills gap and provide accessible learning opportunities. Micro-credentials are seen as a means of achieving lifelong and competency-based learning, enabling individuals to adapt to changes in their profession and stay competitive in the job market.*

***Conclusions*** *– Results showed that as mastery motivation increased, so did math achievement for both genders, but males had higher scores on average. The study suggests that addressing the gender gap in math performance requires a comprehensive approach that considers social and cultural factors, promotes equal opportunities, and resources, and implements inclusive teaching practices. Limitations of the study include using self-reported data and focusing only on grade 12 students.*



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*Recommendations for future research include qualitative studies, longitudinal studies, investigating the impact of different interventions, and considering the role of intersectionality in math performance and motivation.*

**Keywords:** *Gender Achievement Gap, Mastery Motivation, (NAEP) Twelfth-Grade Mathematics Assessment, Achievement Goal Theory, Persistence, Social Desirability Bias, Stereotype Threats*

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## Introduction and Rationale

### Background

The demand for STEM graduates is increasing due to their significant contributions to innovation and economic growth. The National Science Foundation (NSF) predicts that STEM jobs will surpass 2.4 million by 2026 (NSF, 2018), and the US Bureau of Labor Statistics also expects a 33% increase in math-related positions, including statistics, from 2019 to 2029 (US Bureau of Labor Statistics, 2022). The increasing importance of data analysis across various industries, such as healthcare, business, and government, drives the demand for professionals with strong mathematical skills (National Center for Education Statistics, 2019). However, studies have shown that despite this increasing demand, there is a need for more qualified candidates, particularly among underrepresented groups such as women (National Center for Education Statistics, 2019; NSF, 2020).

The gender achievement gap contributes to the lack of qualified women in math (Stoet and Geary, 2018), leading to income inequality, reduced workplace diversity (NSF, 2020) and a gender pay gap (US Census Bureau, 2019). The gender achievement gap starts in the classroom, with males generally outperforming females on math tests, particularly at the highest achievement levels (Else-Quest et al., 2010; Halpern et al., 2011; Hyde et al., 2008; Stoet & Geary, 2015; Stoet & Geary, 2018), although the gap has narrowed in recent years. Male students still tend to score slightly higher on math tests than female students. In 2019, male students in the US scored an average of 158 on the 8th-grade math test and 154 on the 12th-grade math test, compared to 154 and 150 for female students in the same years (NAEP, 2019).

The Organization for Economic Co-operation and Development (OECD) reported in 2019 that the gender gap in math varies by country, with some countries having smaller or opposite gender gaps, such as Qatar, the United Arab Emirates and Japan, while countries like the United States and the United Kingdom have larger gaps (OECD, 2019). Countries with greater gender equality, such as Finland, have relatively small or even opposite gender gaps in math achievement, with females outperforming males (Stoet and Geary, 2018). *What factors could account for the gender differences and variations in math achievement across different countries?*

According to a study by Stoet and Geary in 2018, in more gender-equal countries, the gender gap in math achievement is smaller or even reversed, with females outperforming males. This phenomenon is called the "*Gender-Equality Paradox." The* researchers proposed that females in these gender-equal countries have greater access to educational opportunities and more positive attitudes toward math, leading to higher academic achievement, and males experience less pressure to conform to gender stereotypes about math ability, allowing them to perform in line with their abilities (Stoet and Geary, 2018)**.**

Neuroscience and cognitive science studies found few significant differences in brain structure or function related to math performance (Hugdahl et al., 2006; Hyde et al., 2008; Lindberg et al., 2010). These studies suggested that the reasons for the math achievement gap are complex and multifaceted and may be influenced by cultural attitudes toward gender roles, teaching practices, and educational policies. A meta-analysis by Lindberg et al. (2010) found that social and cultural factors, educational opportunities, experiences with math, and females' tendency to have negative attitudes toward math and less confidence in their abilities contribute to lower math performance.

The gender-equality paradox phenomenon and the results of neuroscience research suggest that differences in math performance gaps are neither biologically determined nor related to innate abilities but affected by social and cultural factors, values, societal expectations, and gender norms. Researchers like Eccles et al. (1993), Józsa & Barrett (2018), Lent et al. (1986), Stevens et al. (2006), and Wang and Degol (2014 and 2016) suggested that *mastery motivation*, a psychological force that stimulates an individual to attempt independently, in a focused and persistent manner, to solve a problem or master a skill or discipline (Morgan et al., 2020), such as math, is shaped by these cultural and societal factors and plays a role in explaining differences in math performance between genders. Wang and Degol (2014 and 2016) found *mastery goals* (i.e., goals focused on learning and improving one's skills) and *persistence* (the ability to continue striving and trying despite difficulties) are predictive of STEM career aspirations and contribute to gender gaps.

### Research Problem

Despite efforts to reduce the gender gap in math, research suggests that males still outperform females, particularly at the highest achievement levels. While the gap has decreased in recent years, male students tend to score slightly higher on math tests than female students. This persistent gender gap is a significant concern as it limits females' opportunities in math-related fields, resulting in underrepresentation in high-paying careers and contributing to income inequality and reduced workplace diversity. Addressing this gap is crucial to ensure equal opportunity for all individuals to develop their math skills and pursue careers in math-related fields.

### Research Deficiencies

This previous research has examined mastery motivation, as measured by mastery goals, performance goals, and persistence, relates to math performance, there is still a lack of research on how these factors work together to impact math performance for twelfth-grade students in the US and whether gender has a moderating effect on this relationship. Understanding how these factors influence math performance in the context of twelfth-grade students is crucial, as this grade is a critical point in students' academic trajectory. This understanding could lead to developing more effective strategies to address gender disparities in math performance.

### Purpose Statement

This study investigates the relationship between mastery motivation and twelfth-grade students' math performance and how gender moderates this relationship. Specifically, this study aims to examine the impact of (1) student's mastery goals, (2) performance goals, and (3) persistence in math on their NAEP twelfth-grade mathematics assessment scores; and (4) explore how gender moderates the relationship between these 3 mastery motivation measurements and twelfth-grade students' math performance.

### Significance of the Research

The study's findings can be valuable for policymakers, educators, and researchers aiming to promote educational equity and excellence. Identifying factors affecting math performance can help design evidence-based interventions and improve math outcomes for all students. Twelfth grade is critical in students' educational trajectory, as their math performance determines their readiness for postsecondary education and future careers. The


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National Assessment of Educational Progress (NAEP) twelfth-grade mathematics assessment is a widely used measure of math performance in the United States. The study's examination of the relationship between mastery motivation and NAEP math scores in grade 12 is crucial in gaining insight into the factors influencing math performance.

**Research Questions**

- RQ1: What was the overall achievement of all students in the 2019 Grade 12 NAEP Mathematics Assessment? What were the differences in achievement between male and female students in the 2019 Grade 12 NAEP Mathematics Assessment, and how significant are these differences?
- RQ2: To what degree does the level of students' mastery motivation, as measured by mastery goals, performance goals, and persistence, relate to their performance on the twelfth-grade Mathematics Assessment?
- RQ3: How does gender, as a moderator, affect the relationship between mastery motivation, measured by mastery goals, performance goals, and persistence, and the Mathematics Assessment scores of male and female students?

## Literature Review

**Introduction**

Recent research challenges the idea that males have a biological advantage in math, finding no significant gender differences in cognitive abilities (Spelke, 2005). Instead, females' lower motivation in math explains the gender gap in math achievement (Burkley et al., 2010; Dweck, 2007). The study explored the relationship between students' mastery motivation, math achievement, and gender to promote gender balance in STEM. The research sought to determine whether students' persistence and mastery-oriented goals for learning math independently predicted math achievement and whether these relationships varied by gender. Using NAEP math achievement outcomes for 2019, the study highlighted the importance of fostering math motivation among female students to improve their participation in STEM courses and programs.

**Achievement goal theory and Math Achievement**

**Achievement Goal Theory**

Janssen and Van Yperen (2004) described *Achievement Goal Theory* as a framework that explains how individuals perceive, process, and react to achievement situations. The theory identifies two approach-oriented motivational patterns, *mastery goals* and *performance goals*. Students with mastery goals focus on acquiring new skills and developing competence, while those with performance goals prioritize showcasing their abilities and outperforming others. Mastery goals lead to active engagement in learning, perseverance, intrinsic motivation, and seeing mistakes as opportunities to learn. In contrast, performance goals lead to a "helpless" motivational pattern involving task avoidance, lower intrinsic motivation, and viewing errors as a sign of failure (Ames and Archer, 1988; Dweck and Leggett, 1988).

Achievement goal theory posits that differences in students' goal orientations account for the differences in their academic performance levels (Covington, 2000). Numerous studies have explored the link between achievement goals and academic achievement. For example, Chan et al. (2008) found that a mastery goal orientation positively impacted deep learning strategies and academic success. Zhou et al. (2010) observed direct and indirect effects of mastery and performance goals on college students' performance achievement. Zingaro et al. (2015) found mastery goals were linked to good exam performance, while performance goals might negatively affect performance, enjoyment, and post-course interest.

However, the effects of performance goals are inconsistent due to differences in definitions (Senko, 2019). Some research suggests that performance-approach goals are linked to positive achievement but may result in superficial learning strategies, while appearance-based performance goals can negatively affect academic achievement (Bong, 2012; Hulleman et al., 2010; Senko & Dawson, 2017). Phillips and Gully (1997) found that performance goal orientation was negatively related to goal level and self-efficacy.

**Achievement Goal Theory and Math Achievements**

Studies indicate that individuals with a mastery goal orientation outperform those with a performance goal orientation in mathematics due to their use of deep learning strategies and persistence in facing challenges. Elliot et al. (2001) discovered that students with a stronger mastery goal orientation achieved higher in mathematics than those with a stronger performance goal orientation because they were more likely to employ deep learning strategies. Wang et al.'s (2011) research demonstrates that students who prioritize mastery goals in math perform better than those who prioritize performance goals. Hulleman et al.'s (2010) meta-analysis revealed that interventions to promote mastery goals effectively enhance math achievement.

On the other hand, those who prioritize performance goals tend to employ surface learning methods that may not lead to a thorough understanding of the subject matter. Wolters and Hussain (2014) found that middle school students who prioritized performance goals had poorer math performance and were less engaged. Hulleman et al.'s (2010) study revealed that high school students randomly assigned to the performance goal condition exhibited lower math performance and was less likely to enroll in advanced math courses than those in the mastery goal condition. Performance goals can lead to adverse outcomes, such as anxiety and test anxiety (Church et al., 2001).

While most research shows a stronger positive correlation between mastery goals and math achievement, some studies have found a positive association between performance goals and math achievement. For example, Chen (2012) discovered that students who prioritized mastery and performance goals had higher math performance than those who emphasized only mastery or performance goals. Similarly, Senko et al. (2012) found that elementary school students who endorsed more performance-approach goals had higher math achievement.

**Achievement Goal Theory and Math Achievement, As Moderated by Gender**

Research findings regarding gender differences in achievement goal orientations have been somewhat inconsistent. While some studies suggest a significant relationship between gender and the type of goal orientations adopted by students in different academic settings and under various conditions, others report no significant differences. For example, Middleton and Midgley (1997) found that males tended to adopt performance-approach goals more often


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than females. Anderman and Young (1994) also reported that males are more likely to adopt performance-approach goals, while females tend to adopt more mastery goals than males. Similarly, Henderson and Dweck (1990) found gender differences, with females being more extrinsic or performance-oriented than males.

Nevertheless, other studies suggest that females are more performance goal-oriented than males (Kwok-wai et al., 2002), while males tend to adopt more performance goals than females (Brdar et al., 2006; Meece et al., 2006). Rashid and Javanmardi (2012) found that mastery goals were the most prevalent goal orientation among male and female students, followed by a performance approach. Similarly, other studies have reported no significant gender differences in students' goal orientations (Abrahamsen et al., 2016; Phan, 2008; Midgley & Middleton, 1997; Smith et al., 2002).

However, these studies suggest that gender differences in math achievement may be related to other factors, such as gender differences in attitudes toward math or gender stereotypes about math ability. Additionally, research indicates that males and females differ in their approaches to academic tasks, which may be linked to the type of goal orientations they adopt. While the relationship between achievement goals and math achievement is generally inconsistent, gender differences may moderate this relationship. As such, it is important to consider gender differences when examining the relationship between achievement goals and math achievement.

**Persistence and Math Achievement**

Persistence refers to the ability to continue striving and trying despite difficulties, opposition, or failure (Wang & Degol, 2016). In the academic context, persistence is crucial for students to achieve their academic goals and is often associated with high motivation. Persistence is also a significant factor in academic success, including math achievement. Studies suggest that students who display persistence in their academic pursuits tend to perform better in math than those who do not (Kälin & Oeri, 2023).

Studies consistently show a positive association between persistence and math achievement (Zmood, 2014; Su & Reeve, 2011; Duckworth & Seligman, 2005; Parada & Verlhiac, 2021). Researchers have found that students' persistence in math is positively correlated with their math achievement and performance. Conversely, students who lack persistence in math tend to have lower math performance than those who are more persistent (Su & Reeve, 2011). High school students' self-discipline, a persistence component, has significantly predicted their math achievement even after controlling for prior math performance and other factors (Duckworth & Seligman, 2005). Moreover, students who display persistence in their math learning tend to have higher self-efficacy, which, in turn, predicts higher math achievement (Parada & Verlhiac, 2021).

Other studies have found that a lack of persistence in math is associated with negative attitudes toward math, such as math anxiety and avoidance. For example, Korem and Rubinsten (2020) found that students who exhibited low persistence in math tended to have higher levels of math anxiety and math avoidance, which, in turn, predicted lower math performance.

**Persistence and Math Achievement, As Moderated by Gender**

Persistence is a trait that individuals of any gender can display, and it refers to the ability to continue working towards a goal despite obstacles or setbacks. However, societal expectations and stereotypes may impact how persistence is expressed or perceived differently by individuals of different genders (Diekman & Eagly, 2012; Ridgeway, 2008). Gender-based stereotypes and expectations can significantly affect how individuals perceive and express their persistence. For example, males may be encouraged to persist in pursuing career success. In contrast, females may be encouraged to pursue domestic duties or care for others, leading to differences in how persistence is valued or recognized (Hinton, 2017; Tabassum & Nayak, 2021). Gender-based stereotypes can also impact how persistence is perceived in interpersonal relationships. These societal expectations and stereotypes can impact how individuals of different genders express and perceive their persistence, potentially affecting their academic and personal success.

Persistence is a complex trait influenced by various factors, including individual differences, societal expectations, and cultural norms (Duckworth & Seligman, 2005). There is no conclusive evidence to suggest that males or females persist more in math. Research on gender differences in math persistence is mixed, with some studies finding no significant gender differences and others finding small gender differences that may vary depending on the specific context or population being studied.

Eccles et al. (1993) found that males and females who perceived themselves as competent in math were more likely to persist in challenging math tasks. Still, females tended to view themselves as less competent and less interested in math. Another study by Crosnoe et al. (2004) found no significant gender differences in math persistence among high school students. Still, females were more likely than males to report feeling anxious or unsure about their math abilities. Crosnoe et al. (2004) suggested that these gender differences in math self-perceptions may be influenced by broader societal expectations and stereotypes shaping how girls view math.

***Mastery Motivation***

The concept of mastery motivation is defined as a psychological force that stimulates an individual to attempt independently, in a focused and persistent manner, to solve a problem or master a skill or discipline (Morgan et al., 2012), and it is associated with persistence, task enjoyment, curiosity, and effort (Keilty & Freund, 2004; Busch-Rossnagel et al., 2016).

Persistence is one of the variables that make up mastery motivation. Mastery goals and performance goals are two related constructs that individuals use to guide their pursuit of a task or activity. It is essential to note that while mastery and performance goals can be significant in motivating individuals to pursue tasks or activities, they do not represent the same variables that make up mastery motivation. Instead, mastery and performance goals reflect different motivational orientations or orientations to achievement that individuals may adopt to pursue their goals. Research studies have shown mastery motivation can predict student achievement (Józsa et al., 2019). According to Sung and Wickrama (2018), persistence is a critical determinant of academic success in students and is associated with a strong preference for mathematical content, leading to sustained commitment over time and improved performance (Jansen et al., 2016; Lee et al., 2014).


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**Mastery Motivation and Math Achievement, As Moderated by Gender**

Mastery-motivated behaviour is characterized by persistence, a drive for a challenge, positive affect, and expectations for future achievement (Burhans & Dweck, 1995). When faced with failure, individuals with a mastery-oriented mindset look for ways to improve their performance and abilities, such as exerting greater effort or taking corrective measures (Hong et al., 1999). In contrast, a helpless behaviour pattern involves less persistence, avoiding risks and upcoming challenges, and having negative affect and expectations for future performance (Burhans & Dweck, 1995). Research indicates that individuals with helpless behaviour tend to experience inconsistent or poor success outcomes, while those with mastery-oriented behaviour patterns are associated with positive achievement outcomes (Murayama & Elliot, 2019).

Studies suggest that males may have more favorable motivational profiles than females regarding mastery-motivated behaviour in mathematics (Kurtz-Costes et al., 2008). In secondary and higher education, females tend to exhibit less enthusiasm and desire to study mathematics (Frenzel et al., 2010; Ganley & Lubienski, 2016). Researchers attribute this disparity to females being more likely to exhibit helplessness in the face of difficulties or failure. Girls' vulnerability to difficulty is evident as early as elementary school (Dweck, 2007). As more complex skills and concepts are introduced in middle and high school math classes, students with less mastery-motivated behaviour may experience more failures and problems, leading to helpless behaviour patterns. Females are more likely to exhibit these behavioral tendencies, which may result in a decline in academic performance, avoidance of challenging math courses, and a decreased interest in pursuing careers in related fields.

# Conclusion

Mastery motivation is a multi-dimensional construct that can be measured through various factors, such as persistence, mastery, and performance goals. Studies consistently demonstrate that individuals with high levels of persistence tend to perform better academically, including in math. Additionally, students who prioritize mastery goals tend to outperform those with performance goals in math, and interventions promoting mastery goals have effectively improved math achievement. However, it is important to consider gender differences in the relationship between persistence, mastery motivation, and math achievement, as these differences may moderate this relationship. Gender-based stereotypes and biases may affect how individuals of different genders perceive and express persistence and mastery motivation, even though research on gender differences in math persistence is mixed.

# Methodology

**What is NAEP?**

The National Assessment of Educational Progress (NAEP) is a standardized test administered by the National Center for Education Statistics (NCES) to measure student achievement across public and private schools in the United States. It is designed to provide a common measure of student achievement that allows for direct comparisons among states and participating urban districts (Education Commission of the States [ECS], 2019; National Center for Education Statistics [NCES], 2022). NAEP is administered to a representative sample of students. Its results are used by policymakers, educators, researchers, parents, and the general public to identify areas where students are struggling, develop strategies for improving student achievement, and advocate for educational improvements (Heafner & Fitchett, 2015; Jones, 1996; Kolhoff & Zhang, 2021; Ogut, 2019; U.S. Department of Education [DoEd], 2020).

**NAEP Background Questionnaires**

The NAEP background questionnaire collects contextual information relevant to the results, including demographic characteristics, socioeconomic status, availability of informational resources at home, and mastery goals. NAEP also administers surveys to teachers and school administrators to gather additional information such as teacher qualifications, instructional approaches, and the availability of varied curriculum and instructional resources. The NAEP background questionnaires have various uses for researchers, educators, and policymakers, such as investigating the connection between student background and academic performance and identifying potential areas for improvement in education (NCES, 2022).

**NAEP Mathematics Assessment and Questionnaire**

The NAEP Questionnaire - Grade 12 Math is a survey instrument accompanying the NAEP mathematics assessment. The questionnaire collects information on demographic and educational backgrounds, experiences, and mathematics-related attitudes tailored to the 12th-grade student population (National Assessment Governing Board [NAGB], 2012; National Center for Education Statistics [NCES], 2020). The collected data provides insight into the characteristics of the students who took the assessment and identifies areas where math education can be improved. Researchers analyze the data collected from the math questionnaire to investigate the correlations between students' mathematics achievement and academic background, including variables such as socioeconomic status, gender, and parental education level. Policymakers and educators utilize the information to create interventions that specifically address the unique challenges and needs of students who struggle with mathematics (Ji et al., 2021; Kolhoff & Zhang, 2021; LaDell-Thoman & Zhang, 2017; Ginsburg & Chudowsky, 2012).

**Participant Data and Sampling**

**NAEP Sampling**

The National Assessment of Educational Progress (NAEP) is administered to a representative sample of students at the national, state, and Trial Urban District Assessment (TUDA) levels using a rigorous sampling approach to ensure that the student samples are representative of the population of interest (National Center for Education Statistics [NCES], 2022). Public schools are selected from the Common Core of Data (CCD) file using stratification based on various characteristics, and private schools are selected using the Private School Universe Survey (PSS). Upon selecting the schools, a probability sample design is used to randomly select a sample of students for assessment (Colorado Department of Education [CDE], 2022; LaDell-Thomas & Zhang, 2017).

**Research Sample and Data Collection**

The study utilized data from the 2019 12th-grade mathematics assessment of NAEP, including public and nonpublic school students. Approximately 1,770 public and private schools were selected to participate, and 25,400 students sat for the assessment. The reported results were based on paper-based and digitally based assessments. The research in this study only focused on variables


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from the student survey questionnaire. Table 1 presents the sample distribution by sex (The Nation's Report Card, 2019).

**Table 1**

Sample Distribution for the 2019 NAEP Mathematics Assessment

| | Analytic Sample | |
|---|---|---|
| **Student Demographic Characteristics** | **Number Of Students** | **Percentage** |
| **Total** | 25,400 | 100 |
| **Gender** | | |
| Male | 12,700 | 50 |
| Female | 12,700 | 50 |

**Selection of Variables**

This section summarizes the independent and dependent variables used in the current study based on the research questions.

**Independent Variable:** This research used one independent variable: mastery motivation, as measured by mastery goals, performance goals, and persistence. Table 2 shows the list of items from the NAEP Questionnaire - Grade 12 Math were used to measure mastery motivation. All of the questions had multiple answers.

**Table 2**

NAEP Questionnaire - Grade 12 Math Question Items Used to Measure Mastery Motivation.

| **Question Item ID** | **Question Item** | **Variable Measured** |
|---|---|---|
| VH733141 | How much does each of the following statements describe you? Select **one** answer choice on each row. | Persistence |
| VH733142 | I finish whatever I begin. | Persistence |
| VH733143 | I try very hard even after making mistakes. | Persistence |
| VH733145 | I keep working hard even when I feel like quitting. | Persistence |
| VH733144 | I keep trying to improve myself, even when it takes a long time to get there. | Persistence |
| VH844871 | How much does each of the following statements describe you? | Performance Goals |
| VH844872 | I want other students to think I am good at math. | Performance Goals |
| VH844873 | I want to show others that my math schoolwork is easy for me. | Performance Goals |
| VH844882 | I want to look smart compared to the other math class students. | Performance Goals |
| VH844871 | I want to get better grades than most other students in my math class. | Performance Goals |
| VH845110 | How much does each of the following statements describe you? | Mastery Goals |
| VH845117 | I want to learn as much as possible in my math class. | Mastery Goals |
| VH845114 | I want to master a lot of new skills in my math class. | Mastery Goals |
| VH845115 | I want to become better in math this year. | Mastery Goals |
| VH845118 | I want to understand as much as I can in my math class. | Mastery Goals |

***Reasoning for using these question items.***

The 2019 Mathematics Grade 12 NAEP background questionnaire includes items VH733141a-d to create the Students' Persistence in Learning index, measuring students' intrinsic motivation to master tasks and maintain sustained effort toward achieving goals. The questionnaire also includes items VH844870a-d to create the Students' Mathematics Performance Goals index, measuring students' focus on achieving specific outcomes or demonstrating ability relative to others. Finally, items VH845110a-d are used to create the Students' Mathematics Mastery Goals index, measuring students' desire to acquire new skills and knowledge to improve their competence in a specific area.

**Dependant Variables:** The research focuses on one dependent variable, which is the 2019 NAEP Mathematics Assessment scores for Grade 12 students.

**Moderator Variables:** The study includes one interaction moderator variables: the interaction between mastery motivation and gender. The gender variable refers to the extent to which students identify as male or female and is hypothesized to affect the relationship between the independent and dependent variables. The gender of the students in the NAEP sample is determined by their school records, where they are classified as either male or female (The Nation's Report Card, 2019).

**Data Analysis**

NAEP results are never reported for individual students; results are reported at the state level and for participating urban districts. Both public and private school results are reported for the nation, but only public-school results are reported at the state level (NCES, 2022).

**NAEP Data Explorer and Cohen's d Effect Sizes**

This study utilized the NAEP Data Explorer (NDE) to analyze the 2019 12th-grade mathematics scores and background questionnaire items. NDE is a web-based statistical processing package that can be accessed for free at https://www.nationsreportcard.gov/ndecore/xplore/NDE . Descriptive tables were generated using NDE, including average scale scores and standard deviation. The study also conducted


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significance tests, specifically t-tests, using NDE to compare the means of two conditions and determine statistical significance.

This study used Cohen's d-effect sizes to supplement the information available from t-tests about the magnitude of the effect being tested. Cohen's d is typically calculated by subtracting one group's mean from the other group's mean and dividing the result by the pooled standard deviation. An online effect size calculator was used to calculate Cohen's d effect sizes. The interpretation of the effect sizes followed Becker's standards, where a Cohen's d of 0.200 was considered a 'small' effect size, 0.500 was considered a 'medium' effect size, and 0.800 was considered a 'large' effect size.

## Results

This section reports on our findings on the impact of various factors such as persistence, performance goals, and mastery goals in mathematics on the NAEP 12th-grade mathematics composite scores for male and female students in 2019. The study includes descriptive tables, significance tests, and Cohen's d calculations to determine the statistical significance and magnitude of the effects being tested. The results are generated using NDE and the online effect size calculator (Becker, 1999).

**Research Question 1**

*What was the overall achievement of all students in the 2019 Grade 12 NAEP Mathematics Assessment? What were the differences in achievement between male and female students in the 2019 Grade 12 NAEP Mathematics Assessment, and how significant are these differences?*

The study utilized the NAEP Data Explorer to examine the overall achievement of all students in the 2019 Grade 12 NAEP Mathematics Assessment and the differences in achievement between male and female students. Table 3 presents the composite scale mean score for the twelfth-grade mathematics assessment at the national level in 2019 without providing the number of students (N) in NAEP Data Explorer. Table 4 presents the average composite scale score at the national level for the 2019 twelfth-grade mathematics assessment, categorized by gender.

**Table 3**

Average scale scores and standard deviations for grade 12 mathematics, by all students [TOTAL] and jurisdiction: 2019.

| Year | Jurisdiction | All students | Average scale score | Standard deviation |
|---|---|---|---|---|
| 2019 | National | All students | 150 | 36 |

**Table 4**

Average scale scores and standard deviations for grade 12 mathematics by gender and jurisdiction: 2019

| Year | Jurisdiction | Gender | Average scale score | Standard deviation |
|---|---|---|---|---|
| 2019 | National | Male | 152 | 37 |
| 2019 | National | Female | 149 | 34 |

The average score for female students in the 2019 NAEP 12th-grade mathematics assessment was 149, with a standard deviation of 34. The average score for male students was 152, with a standard deviation of 37. The difference between genders was 3 points, with males scoring slightly higher. However, male scores had a wider range and variability (SD =37) than female scores (SD = 34), which were more tightly clustered around their average. The literature supports these results about the gender gap in math performance (Frenzel et al., 2010; Ganley & Lubienski, 2016; Kurtz-Costes et al., 2008; Pajares & Miller, 1997; Rodríguez et al., 2020). The difference in the average score is low and consistent with studies that argue the gender gap is narrowing over time. An independent t-test (Table 5) and Cohen's d-effect size were used to determine the significance of the difference, which was found to be significant. Table 6 presents the Cohen's d effect size for the significant differences in mean scores between male and female average scale scores.

**Table 5**

The difference in average scale scores and significance for grade 12 mathematics by gender and jurisdiction: 2019.

| | Male (152) | Female (149) |
|---|---|---|
| **Male (152)** | | ><br>Diff = 3<br>P-value = 0.0000 |
| LEGEND: | | |
| < | Significantly lower | |
| > | Significantly higher | |
| X | No significant difference. | |

*NOTE: Within jurisdictions, comparisons on any given year depend on an alpha level of 0.05.*

**Table 6**

Cohen's d effect size for the significant differences in mean score between male and female average scale scores.

| | Cohen's *d* |
|---|---|
| Effect sizes of significant mean score differences between males and females | 0.08 |

The study found that males have significantly higher average scores in grade 12 mathematics than females, as indicated by the t-test ($p<.001$). However, the effect size, as measured by Cohen's d, was very small (0.08). This means that the difference between male and female scores is considered trivial despite being statistically significant.

**Research Question 2**

*RQ2: To what degree does the level of students' mastery motivation, as measured by mastery goals, performance goals, and persistence relate to their performance on the twelfth-grade Mathematics Assessment?*

To address the question of the overall achievement of all students in the 2019 Grade 12 NAEP Mathematics Assessment, we utilized the NAEP Data Explorer (NDE) to generate the average composite scale scores and standard deviation for all students based on their reported answers to questions items related to persistence (VH733141a-d), performance goals (VH844870a-d), and mastery goals (VH845110a-d).

**Mastery Goals**

The questions VH845110b-d reflect mastery goals in mathematics, which are focused on personal development, growth, and learning. Table 7 shows the average scale score and standard deviation of the Mathematics Mastery Goals index for national students in 2019.


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**Table 7**

Average scale score and standard deviation of the Mathematics Mastery Goals index VH845110b-d for national students in 2019.

| Year | Jurisdiction | Mastery Goals | Average scale score | Standard deviation |
|---|---|---|---|---|
| 2019 | National | Not at all like me | 137 | 32 |
| 2019 | National | A little bit like me | 146 | 33 |
| 2019 | National | Somewhat like me | 150 | 34 |
| 2019 | National | Quite a bit like me | 159 | 35 |
| 2019 | National | Exactly like me | 160 | 37 |

The study found that students who reported higher levels of mastery goals in mathematics had a higher average score (160, SD=37) than those who reported lower levels of mastery goals (137, SD=32), with a difference of 23 points. A significant positive correlation was observed between the level of mastery goals and the average math score. The t-test and Cohen's d effect size were used to determine the significance of these differences. Appendices 1-4 show the differences in means and independent t-test results for the average scale score and Table 8 displays the effect sizes of significant mean score differences for mastery goals. Appendix 5 displays the effect sizes of significant mean score differences for each mastery goals question item.

**Table 8**

The effect sizes of significant mean score differences by mastery goals.

| | **Cohen's *d*** |
|---|---|
| "Not Like me At All" and " Exactly Like me." | 0.66 |
| "Not Like me At All" and " Quite a bit like me." | 0.66 |
| "Exactly like me" and " A little bit like me." | 0.40 |
| "Quite a bit like me" and " A little bit like me" | 0.38 |
| "Not Like me At All" and " A little bit like me." | 0.28 |
| "Not Like me At All" and " Somewhat like me." | 0.28 |
| "Exactly like me" and " Somewhat like me." | 0.28 |
| "Quite a bit like me" and " Somewhat like me" | 0.26 |
| "Somewhat like me" and " A little bit like me." | 0.12 |

According to the study, the highest effect size (d=.66) was found between students who reported high levels of mastery goals and those who reported lowest levels. This effect size was considered medium-to-large according to Cohen's criteria. These findings are in line with the literature review that consistently shows that mastery motivation is a predictor of academic achievement and has a positive impact on students' learning and academic success (Chan et al., 2012; Hulleman et al., 2010; Linnenbrink-Garcia et al., 2008; Van Yperen et al., 2014; Wirthwein et al., 2013; Zhou et al., 2010).

**Performance Goals**

The study found a positive relationship between students' performance goals and math achievement. The questions VH844870b-d reflect performance goals associated with negative outcomes such as anxiety and fear of failure. Students who reported high-performance goals had a higher average (163, SD=37) score. In comparison, those who reported the lowest levels of performance goals had a lower average score of (145, SD=34), with an 18-point difference. This finding is not supported by previous literature that suggests students who focus on outperforming others rather than learning may experience negative academic outcomes (Elliot & Dweck, 1988; Elliot et al., 2000; Pekrun et al., 2009; Phillips and Gully, 1997; Wang et al., 2011; Wolters and Hussain, 2014; Zingaro et al., 2015). Appendices 6-9 display the effect sizes of significant mean score differences between variables, and Table 9 displays the results for national students in 2019 for VH844870b-d. A significant positive correlation was observed between the level of performance goals and the average math score. The effect sizes of significant mean score differences for performance goals were the highest between students who reported "Exactly like me" and those who reported "Not at all like me" (d=.52), indicating a medium-to-large effect size according to Cohen's guideline (Cohen, 1988). Appendix 10 displays the effect sizes of significant mean score differences for each performance goals question item.

**Table 9**

The results for national students in 2019 for VH844870b-d

| Year | Jurisdiction | Performance Goals | Average scale score | Standard deviation |
|---|---|---|---|---|
| 2019 | National | Not at all like me | 145 | 34 |


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| | | | | |
|---|---|---|---|---|
| 2019 | National | A little bit like me | 153 | 35 |
| 2019 | National | Somewhat like me | 154 | 35 |
| 2019 | National | Quite a bit like me | 162 | 34 |
| 2019 | National | Exactly like me | 163 | 37 |

**Table 10**

Mathematics, grade 12, Difference in average scale scores between variables, for Performance Goals.

| | **Cohen's *d*** |
|---|---|
| "Not Like me At All" and " Exactly Like me." | 0.52 |
| "Not Like me At All" and " Quite a bit like me." | 0.50 |
| "Exactly like me" and " A little bit like me." | 0.28 |
| "Quite a bit like me" and " A little bit like me" | 0.26 |
| "Not Like me At All" and " Somewhat like me." | 0.26 |
| "Exactly like me" and " Somewhat like me." | 0.25 |
| "Not Like me At All" and " A little bit like me." | 0.23 |
| "Quite a bit like me" and " Somewhat like me" | 0.23 |
| "Somewhat like me" and " A little bit like me." | 0.03 |

**Persistence**

The questions VH733141b-d are related to persistence, indicating that students value persistence and are willing to continue striving towards their goals despite setbacks or failures, associated with positive outcomes such as increased motivation, achievement, and personal growth. Appendices 11-14 display the differences in means and independent t-test results for grade 12 mathematics performance goals related to persistence. Table 11 shows the results for national students in 2019 for VH733141a-d, which measures the Persistence index.

**Table 11**

Average scale scores and standard deviations for grade 12 mathematics by all students [TOTAL], jurisdiction: 2019, for VH733141b-d.

| **Year** | **Jurisdiction** | **Persistence** | **Average scale score** | **Standard deviation** |
|---|---|---|---|---|
| 2019 | National | Not at all like me | 131 | 38 |
| 2019 | National | A little bit like me | 144 | 36 |
| 2019 | National | Somewhat like me | 148 | 35 |
| 2019 | National | Quite a bit like me | 155 | 34 |
| 2019 | National | Exactly like me | 150 | 36 |

The study found that students who reported high levels of persistence had the highest average math score, while those who reported the lowest levels of persistence had the lowest average math score. As the self-reported level of persistence increased, the average math score also increased. Cohen's d was calculated for the persistence index (Table 12). The highest effect size was found to be d=.67 between students who reported "Quite a bit like me" and those who reported "Not at all like me" with a medium-to-large effect size according to Cohen's guidelines (Cohen, 1988). Appendix 15 displays the effect sizes of significant mean score differences for each persistence question item.

**Table 12**

Mathematics, grade 12, Difference in average scale scores between variables, for Persistence Goals.

| | **Cohen's *d*** |
|---|---|
| "Quite a bit like me" and " Not at all like me" | 0.67 |
| "Very much like me" and "Not at all like me." | 0.51 |
| "Somewhat like me" and " Not at all like me." | 0.47 |
| "A little bit like me" and " Not at all like me" | 0.35 |
| "Quite a bit like me" and " A little bit like me" | 0.31 |
| "Quite a bit like me" and " Somewhat like me" | 0.20 |


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| | |
|---|---|
| "Very much like me" and " A little bit like me." | 0.17 |
| "Somewhat like me" and "A little bit like me." | 0.11 |
| "Very much like me" and "Somewhat like me." | 0.06 |

The study's findings support the idea that persistence is a crucial factor in a student's academic success, particularly in mathematics, and is aligned with previous research that has shown persistence is a predictor of academic success, and students who exhibit higher levels of persistence are more likely to excel in mathematics (Jansen et al., 2016; Lee et al., 2014; Mercader et al., 2017; Pekrun et al., 2017; Putwain et al., 2018; Sung and Wickrama, 2018).

**Research Question 3**

*How does gender, as a moderator, affect the relationship between mastery goals and performance goals, and the Mathematics Assessment scores of male and female students?*

The study aimed to investigate the impact of gender as a moderator on the relationship between mastery motivation factors and Mathematics Assessment scores of male and female students. To achieve this, we used the NAEP Data Explorer to generate national average scores and standard deviations by gender. We conducted cross tabulations to explore the relationship between gender and each question item and conducted a t-test to determine the significance of the difference, while Cohen's d was calculated to determine the effect size.

**Mastery Goals, with a breakdown by gender**

The study calculated the aggregated average scale score for the Mathematics Mastery Goals index using the VH845110b-d measurement. Table 13 displays the average scale scores and standard deviations for grade 12 mathematics by Mastery Goals, gender, and jurisdiction in 2019.

**Table 13**

The average scale scores and standard deviations for grade 12 mathematics by Mastery Goals, gender [GENDER] and jurisdiction: 2019.

| Year | Jurisdiction | Mastery Goals | Male | | Female | | Average Score Difference |
|---|---|---|---|---|---|---|---|
| | | | Average Scale Score | Standard Deviation | Average Scale Score | Standard Deviation | |
| 2019 | National | Not at all like me | 139 | 33 | 134 | 30 | +5 |
| 2019 | National | A little bit like me | 148 | 34 | 144 | 32 | +4 |
| 2019 | National | Somewhat like me | 152 | 34 | 148 | 33 | +4 |
| 2019 | National | Quite a bit like me | 161 | 35 | 157 | 34 | +4 |
| 2019 | National | Exactly like me | 165 | 38 | 155 | 36 | +10 |

The study analyzed the gender difference in mastery goals using t-tests and Cohen's d effect size. Appendices 16-19 show the differences in means and t-test results for the mastery goals question items by gender. Table 14 summarizes the t-test results and the effect sizes of significant mean score differences between male and female students.

**Table 14**

The effect sizes of significant mean score differences between males and females in mastery goals question items.

| **I finish whatever I begin.** | | | |
|---|---|---|---|
| | **t-test** | **Cohen's d** | **Interpretation** |
| A little bit like me | Significantly higher, P-value = 0.0107 | 0.15 | Very Small Effect Size |
| Somewhat like me | Significantly higher, P-value = 0.0389 | 0.05 | Very Small Effect Size |
| Quite a bit like me | Significantly higher, P-value < 0.001 | 0.11 | Very Small Effect Size |
| Exactly like me | Significantly higher, P-value < 0.001 | 0.29 | Medium Effect Size |
| **I want to become better in math this year.** | | | |
| | **t-test** | **Cohen's d** | **Interpretation** |
| Not at all like me | Significantly higher, P-value = 0.0141 | 0.18 | Very Small Effect Size |
| Quite a bit like me | Significantly higher, P-value = 0.0059 | 0.09 | Very Small Effect Size |
| Exactly like me | Significantly higher, P-value < 0.001 | 0.27 | Medium Effect Size |
| **I want to understand as much as I can in math class.** | | | |
| | **t-test** | **Cohen's d** | **Interpretation** |
| Not at all like me | Significantly higher, P-value = 0.0183 | 0.19 | Very Small Effect Size |


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| | | | |
|---|---|---|---|
| A little bit like me | Significantly higher, P-value = 0.0416 | 0.12 | Very Small Effect Size |
| Somewhat like me | Significantly higher, P-value = 0.0018 | 0.15 | Very Small Effect Size |
| Quite a bit like me | Significantly higher, P-value < 0.001 | 0.12 | Very Small Effect Size |
| Exactly like me | Significantly higher, P-value < 0.001 | 0.25 | Medium Effect Size |
| **I want to master a lot of new skills in my math class.** | | | |
| | **t-test** | **Cohen's d** | **Interpretation** |
| Not at all like me | Significantly higher, P-value = 0.0088 | 0.16 | Very Small Effect Size |
| Somewhat like me | Significantly higher, P-value < 0.001 | 0.12 | Very Small Effect Size |
| Quite a bit like me | Significantly higher, P-value = 0.0270 | 0.08 | Very Small Effect Size |
| Exactly like me | Significantly higher, P-value < 0.001 | 0.27 | Medium Effect Size |

Tables 15 show the average scale scores and standard deviation for aggregated mastery goals question items for both genders, with t-tests to determine the significant difference between students who reported the highest levels of mastery goals and those who reported lower levels. The magnitude of significance was determined using Cohen's d.

**Table 15**

Average scale scores and standard deviations for grade 12 mathematics by Mastery Goals, gender [GENDER] and jurisdiction: 2019.

| **Male** | | | | | |
|---|---|---|---|---|---|
| Mastery Goals | Average scale score | SD | Difference (Exactly like me and Corresponding QI) | Cohen's d | Interpretation |
| Not at all like me | 139 | 33 | 27 | 0.73 | Medium-to-large Effect Size |
| A little bit like me | 148 | 34 | 17 | 0.46 | Small-to-Medium Effect Size |
| Somewhat like me | 152 | 34 | 14 | 0.36 | Small-to-Medium Effect Size |
| Quite a bit like me | 161 | 35 | 4 | 0.13 | Very Small Effect Size |
| **Female** | | | | | |
| Mastery Goals | Average scale score | SD | Difference (Exactly like me and Corresponding QI) | Cohen's d | Interpretation |
| Not at all like me | 134 | 30 | 21 | 0.63 | Medium-to-large Large Effect Size |
| A little bit like me | 144 | 32 | 11 | 0.32 | Small-to-Medium Effect Size |
| Somewhat like me | 148 | 33 | 7 | 0.20 | Small Effect Size |
| Quite a bit like me | 157 | 34 | -2 | -0.05 | Very Small Effect Size |

**Performance Goals, with a breakdown by gender**

The study calculated the average scale score and standard deviation for the Mathematics Performance Goals index using the VH844870b-d measurement. Table 16 displays the results for national students in 2019.

**Table 16**

The average scale scores and standard deviations for grade 12 mathematics, by Performance Goals, gender [GENDER] and jurisdiction: 2019.

| Year | Jurisdiction | Mastery Goals | Male | | Female | | Average Score Difference |
|---|---|---|---|---|---|---|---|
| | | | Average Scale Score | Standard Deviation | Average Scale Score | Standard Deviation | |
| 2019 | National | Not at all like me | 148 | 36 | 142 | 33 | +6 |
| 2019 | National | A little bit like me | 158 | 36 | 150 | 33 | +8 |
| 2019 | National | Somewhat like me | 155 | 36 | 152 | 34 | +3 |
| 2019 | National | Quite a bit like me | 164 | 35 | 161 | 33 | +3 |
| 2019 | National | Exactly like me | 165 | 37 | 160 | 36 | +5 |


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The study used t-tests and Cohen's d-effect size to examine the significance of gender differences in performance goals. Appendices 20-23 present the differences in means and independent t-test results for the average scale scores for grade 12 mathematics for specific performance goals by gender. Table 17 displays the average scale scores and standard deviation for each question item for both males and females, along with t-tests to determine the significant difference between those who reported the highest levels and those who reported lower levels of mastery goals and the magnitude of the significance, Cohen's d.

**Table 17**

The effect sizes of significant mean score differences between males and females in performance goals question items.

| **I want other students to think I am good at math** | | | |
|---|---|---|---|
| | **t-test** | **Cohen's d** | **Interpretation** |
| Not at all like me | Significantly higher, P-value < 0.001 | 0.18 | Very Small Effect Size |
| A little bit like me | Significantly higher, P-value < 0.001 | 0.29 | Medium Effect Size |
| Somewhat like me | Significantly higher, P-value < 0.001 | 0.12 | Very Small Effect Size |
| Quite a bit like me | Significantly higher, P-value = 0.0222 | 0.12 | Very Small Effect Size |
| Exactly like me | Significantly higher, P-value = 0.0109 | 0.30 | Medium Effect Size |
| **I want to show others that math schoolwork is easy** | | | |
| | **t-test** | **Cohen's d** | **Interpretation** |
| Not at all like me | Significantly higher, P-value < 0.001 | 0.17 | Very Small Effect Size |
| A little bit like me | Significantly higher, P-value < 0.001 | 0.17 | Very Small Effect Size |
| Quite a bit like me | Significantly higher, P-value = 0.0131 | 0.12 | Very Small Effect Size |
| Exactly like me | Significantly higher, P-value = 0.0217 | 0.11 | Very Small Effect Size |
| **I want to look smart in comparison to others in math** | | | |
| | **t-test** | **Cohen's d** | **Interpretation** |
| Not at all like me | Significantly higher, P-value < 0.001 | 0.21 | Medium Effect Size |
| A little bit like me | Significantly higher, P-value < 0.001 | 0.20 | Medium Effect Size |
| Exactly like me | Significantly higher, P-value < 0.0264 | 0.11 | Very Small Effect Size |
| **I want to get better grades than most other students in my math class** | | | |
| | **t-test** | **Cohen's d** | **Interpretation** |
| Not at all like me | Significantly higher, P-value = 0.0031 | 0.17 | Very Small Effect Size |
| A little bit like me | Significantly higher, P-value < 0.001 | 0.26 | Medium Effect Size |
| Somewhat like me | Significantly higher, P-value = 0.0340 | 0.06 | Very Small Effect Size |
| Exactly like me | Significantly higher, P-value < 0.001 | 0.16 | Very Small Effect Size |

Tables 18 shows the average scale scores and standard deviation for aggregated performance goals question items for both genders, with t-tests to determine the significant difference between students who reported the highest levels of mastery goals and those who reported lower levels and Cohen’s d to determine the magnitude of the significant difference.

**Table 18**

Average scale scores and standard deviations for grade 12 mathematics by Performance Goals, gender [GENDER] and jurisdiction: 2019.

| **Male** | | | | | |
|---|---|---|---|---|---|
| Performance Goals | Average scale score | SD | Difference (Exactly like me and Corresponding QI) | Cohen's d | Interpretation |
| Not at all like me | 148 | 36 | 17 | 0.45 | Medium-to-large Effect Size |
| A little bit like me | 158 | 36 | 8 | 0.20 | Medium Effect Size |
| Somewhat like me | 155 | 36 | 10 | 0.27 | Medium Effect Size |


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| | | | | | |
|---|---|---|---|---|---|
| Quite a bit like me | 164 | 35 | 1 | 0.00 | No significant difference |
| **Female** | | | | | |
| Performance Goals | Average scale score | SD | Difference (Exactly like me and Corresponding QI) | Cohen's d | Interpretation |
| Not at all like me | 142 | 33 | 18 | 0.52 | Medium-to-large Effect Size |
| A little bit like me | 150 | 33 | 11 | 0.29 | Medium Effect Size |
| Somewhat like me | 152 | 34 | 8 | 0.23 | Medium Effect Size |
| Quite a bit like me | 161 | 33 | -1 | 0.00 | No significant difference |

**Persistence, with a breakdown by gender**

The study calculated the average scale score and standard deviation for the Persistence index using the VH733141a-d measurement. Table 19 displays the results for national students in 2019. The study used t-tests and Cohen's d effect size to examine the gender difference in persistence. The results were displayed in Appendices 24-27, showing the differences in means and independent t-test results for the average scale scores for specific persistence question items cross-tabulated by gender. Table 20 shows the effect sizes of significant mean score differences between males and females.

**Table 19**

Average scale scores and standard deviations for grade 12 mathematics, by Persistence, gender [GENDER] and jurisdiction: 2019.

| Year | Jurisdiction | Persistence | Male | | Female | | Average Score Difference |
|---|---|---|---|---|---|---|---|
| | | | Average Scale Score | Standard Deviation | Average Scale Score | Standard Deviation | |
| 2019 | National | Not at all like me | 132 | 39 | 130 | 36 | +2 |
| 2019 | National | A little bit like me | 148 | 38 | 139 | 35 | +9 |
| 2019 | National | Somewhat like me | 149 | 36 | 145 | 33 | +4 |
| 2019 | National | Quite a bit like me | 156 | 35 | 153 | 33 | +3 |
| 2019 | National | Exactly like me | 152 | 37 | 149 | 35 | +3 |

**Table 20**

The effect sizes of significant mean score differences between males and females in persistence question items.

| **I finish whatever I begin** | | | |
|---|---|---|---|
| | **t-test** | **Cohen's d** | **Interpretation** |
| A little bit like me | Significantly higher, P-value < 0.001 | 0.29 | Medium Effect Size |
| Somewhat like me | Significantly higher, P-value = 0.0049 | 0.09 | Very Small Effect Size |
| Quite a bit like me | Significantly higher, P-value < 0.001 | 0.12 | Very Small Effect Size |
| **I make great effort even after making mistakes** | | | |
| | **t-test** | **Cohen's d** | **Interpretation** |
| A little bit like me | Significantly higher, P-value = 0.0034 | 0.19 | Very Small Effect Size |
| Somewhat like me | Significantly higher, P-value < 0.001 | 0.14 | Very Small Effect Size |
| Quite a bit like me | Significantly higher, P-value = 0.0014 | 0.09 | Very Small Effect Size |
| Exactly like me | Significantly higher, P-value = 0.0084 | 0.08 | Very Small Effect Size |
| **I keep working hard even when I feel like quitting** | | | |
| | **t-test** | **Cohen's d** | **Interpretation** |
| Not at all like me | No significant difference | 0.10 | Very Small Effect Size |
| A little bit like me | Significantly higher, P-value < 0.001 | 0.34 | Medium-to-large Effect Size |
| Somewhat like me | Significantly higher, P-value = 0.0021 | 0.12 | Very Small Effect Size |


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| | | | |
|---|---|---|---|
| Quite a bit like me | Significantly higher, P-value = 0.0242 | 0.06 | Very Small Effect Size |
| Exactly like me | Significantly higher, P-value = 0.0242 | 0.06 | Very Small Effect Size |
| **I keep trying to improve self, even if it takes long** | | | |
| | **t-test** | **Cohen's d** | **Interpretation** |
| A little bit like me | Significantly higher, P-value = 0.0016 | 0.22 | Medium Effect Size |
| Somewhat like me | Significantly higher, P-value = 0.0062 | 0.12 | Very Small Effect Size |
| Quite a bit like me | Significantly higher, P-value = 0.0179 | 0.09 | Very Small Effect Size |
| Exactly like me | Significantly higher, P-value = 0.0007 | 0.08 | Very Small Effect Size |

The study used Cohen's d to determine the significance of the difference in persistence levels for both males and females. Table 21 shows the average scale scores and standard deviation for each question item for both genders, along with Cohen's d used to determine the magnitude of the significance.

**Table 21**

Average scale scores and standard deviations for grade 12 mathematics, by Persistence, gender [GENDER] and jurisdiction: 2019.

| **Male** | | | | | |
|---|---|---|---|---|---|
| Persistence Goals | Average scale score | SD | Difference (Exactly like me and Corresponding QI) | Cohen's d | Interpretation |
| Not at all like me | 132 | 39 | 20 | 0.53 | Medium Effect Size |
| A little bit like me | 148 | 38 | 4 | 0.11 | Very small effect size |
| Somewhat like me | 149 | 36 | 2 | 0.08 | Very small effect size |
| Quite a bit like me | 156 | 35 | -4 | -0.11 | Very small effect size |
| **Female** | | | | | |
| Persistence Goals | Average scale score | SD | Difference (Exactly like me and Corresponding QI) | Cohen's d | Interpretation |
| Not at all like me | 130 | 36 | 19 | 0.54 | Medium Effect Size |
| A little bit like me | 139 | 35 | 10 | 0.29 | Small Effect Size |
| Somewhat like me | 145 | 33 | 4 | 0.12 | Very small effect size |
| Quite a bit like me | 153 | 33 | -4 | -0.12 | Very small effect size |

**Mastery Motivation**

The researcher aggregated the findings from mastery goals, performance goals, and persistence into mastery motivation, presented in Table 22. We compared the average scale scores and standard deviations for male and female students across different levels of mastery motivation, as well as the difference and Cohen's d effect size between the two groups. The data suggests that, on average, males outperformed females in mathematics across all levels of mastery motivation, with the difference ranging from 3 to 7 points. However, the effect sizes (Cohen's d) for the differences are small, ranging from 0.09 to 0.20, indicating that the effect of gender on math performance is relatively small.

**Table 22**

The average scale scores and standard deviations for grade 12 mathematics by Mastery Goals, gender [GENDER] and jurisdiction: 2019.

| **Mastery Motivation** | **Male** | | **Female** | | **Difference** | **Cohen's d** |
|---|---|---|---|---|---|---|
| | **Average scale score** | **SD** | **Average scale score** | **SD** | | |
| Not at all like me | 140 | 36 | 135 | 33 | +4 | 0.14 |
| A little bit like me | 151 | 36 | 144 | 33 | +7 | 0.20 |
| Somewhat like me | 152 | 35 | 148 | 33 | +4 | 0.12 |
| Quite a bit like me | 160 | 35 | 157 | 33 | +3 | 0.09 |


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| | | | | | | |
|---|---|---|---|---|---|---|
| Exactly like me | 161 | 38 | 155 | 36 | +6 | 0.16 |

## Discussion

The gender gap in math performance restricts females' opportunities in math-related fields, contributing to income inequality and workplace diversity issues. This study aims to investigate the relationship between mastery motivation and twelfth-grade students' math performance, with a focus on gender's moderating effect. Since the National Assessment of Educational Progress (NAEP) twelfth-grade mathematics assessment is widely used in the United States, analyzing the relationship between mastery motivation and NAEP math scores in grade 12 is crucial for gaining insight into factors affecting math performance. This section discusses the study's findings based on the analysis of the 2019 Grade 12 NAEP Mathematics Assessment, aligning the results with the supporting hypotheses and previous research.

### Research Question 1

In the 2019 NAEP 12th-grade mathematics assessment, male students scored slightly higher than female students by 3 points, with male scores having a wider range and variability than female scores. The gender gap in math performance has been supported by previous literature (Frenzel et al., 2010; Ganley & Lubienski, 2016; Kurtz-Costes et al., 2008; Pajares & Miller, 1997; Rodríguez et al., 2020), but studies suggest it is narrowing over time. An independent t-test and Cohen's d-effect size confirmed the significance of the difference, with a very small effect size (d= 0.08), indicating the difference is trivial despite being statistically significant. Female scores were more tightly clustered around their average, while male scores were more spread out. The Greater Male Variability Hypotheses can explain this difference in variability.

### Greater Male Variability Hypothesis

The Greater Male Variability Hypothesis is a theory in psychology that suggests that males exhibit greater variability than females across various measures of cognitive ability, personality traits, and interests (Halpern et al., 2007). This hypothesis posits that men are more likely to be found at these distributions' low and high ends, while women are more likely to be clustered around the average. Several studies have found evidence to support the Greater Male Variability Hypothesis. For instance, research has consistently shown that males are more likely than females to have either very high or very low IQ test scores (Machin & Pekkarinen, 2008). Scholars have attributed these observed differences to a combination of genetic factors, environmental conditioning, and interactions between the two (He et al., 2013).

However, the Greater Male Variability Hypothesis is not without controversy. Some researchers have argued that societal expectations and gender stereotypes may contribute to differences in variability between males and females (Baye & Monseur, 2016). For example, females may be discouraged from pursuing certain fields or activities, leading to a smaller proportion of women at the high end of certain distributions. Conversely, males may be encouraged to pursue these same fields or activities, leading to a larger proportion of men at the high end.

### Research Question 2

The study found a positive correlation between mastery goals and math achievement in students, supporting previous research indicating that mastery goals have a positive impact on students' learning and academic success. The study also found a positive correlation between performance goals and math achievement, contradicting previous literature suggesting that performance goals may lead to negative academic outcomes. The study also supported previous research indicating that persistence is a crucial factor in academic success, particularly in mathematics, and can enhance students' self-efficacy and motivation to persist in their academic pursuits.

### Mastery Goals Findings

The study found that students who reported higher levels of mastery goals in mathematics had a higher average score than those who reported lower levels of mastery goals, with a significant positive correlation between the level of mastery goals and the average math score. The study's findings support the idea that mastery goals orientation has a positive impact on students' learning and academic success, and several studies have demonstrated this relationship (Chan et al., 2012; Hulleman et al., 2010; Linnenbrink-Garcia et al., 2008; Van Yperen et al., 2014; Wirthwein et al., 2013; Zhou et al., 2010). The highest effect size was found between students who reported high levels of mastery goals and those who reported low levels, with a medium-to-large effect size according to Cohen's criteria.

Moreover, the analysis revealed two findings. Firstly, the variability of average scores was higher among students who reported high mastery goals, performance goals, and mastery scores and scored the highest in math assessment. However, the variability decreased as these variables decreased, and students scored lower in math assessments. Secondly, students who reported "very much like me" to several mastery goals, performance goals, and persistence question items scored lower than those who reported "Quite a bit like me." The researcher suggests that these findings may be explained respectively by "Multiple Intelligences Theory," "The Matthew Effect," and "Overconfidence and Self-Reporting Accuracy."

### Scores Variability - The Role of Multiple Intelligences

We argue that the larger variability in average scores among high-performing students compared to low-performing students may be related to the fact that higher-performing students have a wider range of abilities and interests, potentially leading to greater variability in performance (Gardner, 1997; Radin & Dannenhoffer, 1997). This phenomenon can be explained using the Multiple Intelligences Theory developed by Gardner, which posits that human intelligence is divided into distinct modalities, and individuals have different strengths and weaknesses across these different intelligences, leading to variability in performance in different areas. Higher-performing students may have a wider range of abilities and interests across these intelligences, while low-performing students may have more similar levels of strengths and weaknesses across them. Additionally, low-performing students may have consistent weaknesses in their knowledge, which could contribute to less variability in their performance (Gardner, 1997).

### Scores Variability - The Matthew Effect

The larger variability in average scores among high-performing students compared to low-performing students may be explained


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by the Matthew Effect, referring to cumulative advantage and disadvantage that can occur over time (Herrmann et al., 2021; Merton, 1968; Stanovich, 1986). Some high-performing students may have advantages in terms of resources such as advanced coursework, tutoring, academic support, or other resources that help them build upon their strengths and continue to perform well. In contrast, high-performing students who have a disadvantage in terms of resources might experience setbacks or barriers that reduce their opportunities for success.

**Overconfidence and Self-Reporting Accuracy**

Students who reported that the mastery goals items were "very much like me" scored lower on academic performance than those who reported that these items were "quite a bit like me." A possible interpretation of these findings is overconfidence, a feeling of self-assurance and belief in one's abilities. Overconfidence can lead to complacency, where students may not put in as much effort or preparation as they should. This can ultimately result in lower academic performance, even if the student believes they can achieve mastery goals. The students do not have a realistic understanding of their abilities and the effort required to achieve their goals (Moores & Chang, 2009).

**Performance Goals Findings**

The study found a positive correlation between students' performance goals and math achievement, with higher performance goals associated with higher average math scores. This finding contradicts previous literature suggesting that performance goals may lead to negative academic outcomes (Elliot & Dweck, 1988; Elliot et al., 2000; Pekrun et al., 2009; Phillips and Gully, 1997; Wang et al., 2011; Wolters and Hussain, 2014; Zingaro et al., 2015). The highest effect size was observed between students who reported: "Exactly like me" and "Not at all like me" (d=0.52).

Though the study's results do not align with previous research indicating that performance goals predict high achievement and adaptive outcomes, they align with Zingaro's (2015) findings that mastery goals are related to good exam performance and performance goals may have negative consequences. Furthermore, the results do not support Phillips and Gully's (1997) research, which suggests that performance goal orientation correlates negatively with goal level, self-efficacy, and performance.

**The Protective Role of Motivation and Self-Efficacy**

One explanation for the positive relationship between performance goals and math is that students who reported high levels of appearance-based performance goals may also have high levels of mastery motivation and self-efficacy, which are predictors of academic achievement (Senko, 2016, 2019). These students may have adopted adaptive learning strategies, such as seeking help when needed, engaging in effective study habits, and persisting through challenges, contributing to their higher math scores. In this case, motivation and self-efficacy are protective factors that mitigate the negative outcomes associated with performance goals. These goals motivate students to engage in adaptive learning strategies and achieve positive academic outcomes. However, it is important to note that this is just one possible scenario, and further research is needed to understand the complex relationship between performance goals, motivation, and academic achievement.

**Persistence Findings**

The study found that students who reported higher levels of persistence had higher average math scores, while those who reported lower levels of persistence had lower average math scores. The self-reported level of persistence was positively correlated with math achievement. The highest effect size was observed between students who reported "Quite a bit like me" and "Not at all like me" (d=0.67). The study's findings support previous research (Jansen et al., 2016; Lee et al., 2014; Mercader et al., 2017; Pekrun et al., 2017; Putwain et al., 2018; Sung and Wickrama, 2018) indicating that persistence is a crucial factor in academic success, particularly in mathematics, and can enhance students' self-efficacy and motivation to persist in their academic pursuits.

**Research Question 3**

**Achievement Goal Orientation Goals Findings**

**Math Gender Gap: An Analysis of Performance and National Averages**

The study explored the impact of gender on the relationship between mastery motivation factors and Mathematics Assessment scores in grade 12 students. The results indicated that males scored higher than females in all mastery and performance goal items regardless of their level of mastery or performance goals, but the effect size was small. The widest gap was observed in students who reported the highest mastery goals, where males scored 5 points above the national average of 150 (SD=36), and females scored 5 points below it. The "Stereotype Threat" can explain these results. However, a medium effect size was found between males' and females' scores for the highest mastery goals. In contrast, the largest gap for performance goals was found in students who reported lower performance goals, where males scored 5 points above the national average, whereas females scored 3 points below it.

Our research findings indicate a consistent gender difference in math achievements based on mastery and performance goals orientation. According to Brandts et al. (2021), males tend to score higher than females even when they report the same level of mastery or performance goals. We suggest that this may be due to males emphasizing academic achievement and taking a more active role in pursuing mastery goals, possibly because they have greater self-efficacy in math and a more positive attitude toward learning. Conversely, females may prioritize other aspects of their lives or face social and cultural barriers that result in lower self-efficacy and confidence in their math abilities. These differences may contribute to the achievement gap in mathematics (Brandts et al., 2021).

Research suggests that there may be a gender difference in math achievement related to performance goal orientation. Males may have an advantage over females even when they report the same performance goals. This could be because males tend to adopt a competitive mindset when approaching math problems (Boekaerts et al., 1995), giving them an advantage when they need to perform well under pressure or in high stakes testing situations. In contrast, females value cooperation and collaboration in learning environments, which may not be as advantageous when individual performance is emphasized, such as in testing situations. However, it is important to note that other factors, such as gender biases in math and differences in opportunities for engagement and encouragement, may also contribute to the gender gap (Boekaerts et al., 1995; Lindberg et al., 2010).

The analysis suggests a gender-based achievement gap in mathematics extends beyond mastery and performance goals. Male students consistently outperformed females, and the national average, while female students consistently scored below males


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and the national average, regardless of their mastery and performance goals. This indicates that females are not only underperforming compared to males but also below the national average. The achievement gap could be due to unequal access to educational resources or societal expectations regarding gender and achievement.

**The Magnitude of Significance and the Threshold Effect**

The study found a significant difference in the relationship between mastery goals and gender, with males showing a larger magnitude of significance than females. This difference in magnitude was consistent across all questions and mastery goals; specifically, the study found that the difference between males who reported "Not like me at all" and “Exactly like me” to "I finish whatever I begin" was larger than the difference found in females, with Cohen's d effect sizes of 0.75 and 0.67, respectively.

The study found that the largest score difference between males and females in mastery goals was for those who reported "Exactly like me" to any of the question items, with males outperforming females by 9-11 points on the different questions. In contrast, the smallest score difference between males and females was for those who reported "Somewhat like me" to the same questions, with a difference of only 2-5 points. These findings were consistent when comparing males and females to the national average scale scores and standard deviations for grade 12 mathematics by mastery goals. The largest difference was seen in students who reported the highest mastery goals, where males scored 5 points above the national average of 165 (SD = 38), and females scored 5 points below it 155 (SD = 36).

The larger score difference between males and females who answered "Exactly like me" on mastery goal questions could be attributed to the “*threshold effects”* phenomenon, where a minimum level of mastery motivation needs to be reached before a significant increase in academic performance is observed (Dictionary of Psychology, 2023). This means that a threshold level of mastery motivation may be required to make a meaningful difference in academic performance. The difference in academic achievement between males and females at this level of motivation may not be as substantial for those who answered: "Somewhat like me."

Hence, the gap in academic achievement between males and females with high levels of mastery motivation may be more evident among those who answered, "Just like me." Additionally, gender differences in goal perceptions and goal setting and personal and cultural backgrounds could also influence these results.

The study found that males and females who reported high-performance goals scored significantly higher than those who reported low-performance goals. However, the effect size was larger for females with a Cohen's d of 0.52 than males with a Cohen's d of 0.45. This suggests that the effect of performance goals on scores is stronger for females than males. One possible explanation for this difference is that the variability in scores among females who reported high-performance goals is smaller than that among males who reported high-performance goals. However, further research is needed to understand the difference in effect sizes between females and males concerning performance goal orientation.

**The Medium-Effect Size and the Stereotype Threat**

According to the “*Stereotype Threat*” theory, members of negatively stereotyped groups will only underperform on tasks related to the stereotype if they strongly identify with the measured construct (Keller, 2007). This means that stereotype threat will only affect women's performance on mathematics tests if they consider mathematics to be important to them. Women who are weakly identified with mathematics are less likely to experience anxiety or negative thoughts during test-taking because they may not be as interested in performing well in mathematics as women who strongly identify with the subject (Keller, 2007; Steinberg et al., 2012).

Several studies have found that women with high domain identification experience higher performance decrements under stereotype threat than those with low domain identification (Steinberg et al., 2012). Walton and Cohen (2003) found that stereotype threat effects were larger in studies with highly identified participants in the stereotyped domain.

**Gender Discrepancy in Score Increases as Performance Goal Levels Increase**

The study found that males' scores increased much more than females' as their reported mastery goal levels increased. This gender difference could be due to differences in self-efficacy and motivation levels between males and females and gender stereotypes and biases in the classroom. Males may have higher levels of self-efficacy and motivation in math, leading to differences in learning behaviour and strategies. In contrast, females may experience stereotype threats in math that could lead to anxiety and decreased performance. Additionally, males may receive more attention and encouragement from math teachers, leading to greater motivation and higher performance increases. These factors could contribute to the difference in the increase in math scores between males and females as they advance in their mastery goal levels. However, further research is needed to understand this phenomenon fully.

The study found that males' scores increased less than females' as their reported performance goals increased. This gender difference could be related to socialization and cultural factors, where males and females may be socialized differently concerning their goals. Females may have been more likely to pursue performance goals due to specific incentives or opportunities, even if they are often encouraged to prioritize mastery goals in other contexts. This conclusion is supported by Chan et al. (2004), whose research found that female students are more performance goal-oriented than male students.

The study found that the question items that measure performance goals are appearance-related, such as "I want other students to think I am good at math" and "I want to look smart in comparison to others in math." Research has shown that appearance-related goals are more prevalent among females than males and that females may be more likely to experience negative psychological and emotional outcomes when their appearance-related goals are not met. This suggests that females who report high levels of appearance performance goals may experience greater pressure or socialization to prioritize these goals, which could result in a larger effect size for females than males. This conclusion is supported by research by Elliot and McGregor (2001) and Wang and Eccles (2013), who found that females tend to report higher levels of performance-approach goals. However, it's important to note that


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this is a hypothetical scenario. The specific results would depend on sample characteristics and other factors, such as societal and cultural norms and expectations surrounding gender roles and appearance, which can vary across different cultures and periods.

**Persistence Findings**

**Math Gender Gap: An Analysis of Performance and National Averages**

The study found that male students performed better than female students in grade 12 mathematics across all levels of persistence. Both male and female students with higher levels of persistence tended to score higher on the mathematics test. Still, the effect size of gender differences in average scale scores was relatively small, ranging from 0.05 to 0.25. The standard deviations of the average scale scores were relatively consistent across all groups.

The study found that persistence positively correlates with math performance in grade 12 students, and males outscored females across all persistence levels. The standard deviations were consistent, indicating similar variability in math performance regardless of gender or persistence. The results suggest that gender and persistence are important factors in math performance, with males generally performing better and persistence having a positive association with math scores, consistent with previous research.

**Multiple Motivational Factors and Persistence-Related Approaches**

Males tend to score higher in math than females, even when they report the same level of persistence. This could be due to various factors, including the possibility that persistence is just one aspect of motivation, and other factors may play a role. Previous research suggests that males may be more intrinsically motivated to learn math, while females may be more extrinsically motivated. Additionally, previous analysis on mastery and performance goals supports this explanation (Gaspard et al., 2015; Steinmayr & Spinath, 2010).

Another explanation for the gender differences in math performance related to persistence is that males and females may have different approaches to persistence. Males may be more likely to use problem-focused coping strategies, actively seeking to solve the problem. In contrast, females may use emotion-focused coping strategies, managing their emotional response to the problem (Tamres et al., 2002). Additionally, research suggests that males may be more likely to persist in the face of failure and attribute it to external factors. In contrast, females may attribute it to a lack of ability (Dweck, 2007). These differences in attribution style could impact persistence and contribute to gender differences in math performance.

The study found that the effect size of persistence on math scores is generally larger for females than males, with both genders showing an effect size range of 0.53 to -0.11 across different levels of persistence. However, the study also found that the differences in math scores between females who identify with different levels of persistence are generally larger than the corresponding differences for males.

The gender differences in math scores may be greater for females due to the obstacles and discrimination they face in STEM fields compared to males, such as stereotype threat, bias, and lack of representation and support (Cheryan et al., 2009; Moss-Racusin et al., 2012). These factors can lead to lower motivation and self-efficacy for females in STEM, requiring them to exhibit higher persistence and determination to succeed. Therefore, persistence may be a more critical factor for females to overcome the challenges they face in STEM, explaining why the effect size of persistence on math scores is generally larger for females than males.

**Gender Discrepancy in Score Increases as Persistence Levels Increase**

The data showed that as the persistence level increases, male and female scores tend to increase, except for a slight decrease for "Quite a bit like me." However, the increase in females' scores was much higher than in male scores as their reported persistence levels increased. Although females tend to have a greater increase in scores than males at each level of persistence, the statistics suggest that females may face more obstacles to achieving the same level of success in mathematics as males, potentially due to gender bias, discrimination, stereotypes, or lack of support and encouragement.

**Mastery Motivation**

There seems to be a positive association between mastery motivation and math performance for both males and females, as the scores tend to increase as mastery motivation increases. However, the increase in scores is inconsistent across all levels, with a slight decrease for the "Quite a bit like me" level. The data suggests that gender is a factor in math performance, with males generally outscoring females. However, the effect of gender is relatively small, and there is a positive association between mastery motivation and math performance for both males and females.

## Conclusion

This study investigated the relationship between students' mastery motivation, math achievement, and gender. The study aimed to determine whether students' persistence and mastery-oriented goals for learning math predicted math achievement and whether these relationships varied by gender, using the National Assessment of Educational Progress (NAEP) math achievement outcomes for 2019.

The results indicated that the average scores on the math exam increased as the level of mastery motivation increased for both males and females. The results suggest that the self-determination theory (SDT) is consistent with the finding that the average scores on the math exam increased as mastery motivation increased. However, despite reporting the same level of motivation, males had higher average scores than females for each level of Mastery Motivation. While this difference was statistically significant, Cohen's d indicated that the effect size was small. Furthermore, comparing average scores between males and females and the national average revealed that females had scores below the national average at all motivation levels. In contrast, males had scores above the national average.

The findings suggest a gender gap in the performance of grade 12 students in mathematics as supported by reviewed literature (Chan et al., 2012; Elliot et al., 2000; Elliot et al., 2000; Harackiewicz et al., 2016; Phillips and Gully, 1997; Wang et al., 2011; Zingaro et


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al., 2015). These findings are also consistent with the stereotype threat theory, which suggests that the fear of confirming a negative stereotype about one's group can impair the performance, particularly in situations where the stereotype is salient. In this case, the stereotype that females are not as competent as males in math could impact female students' performance, even if they are highly motivated.

Various factors, such as socioeconomic background, access to resources, teaching methods, and personal learning styles, may influence the finding of the gender gap in math performance. It is important to note that social and cultural factors shape gender differences in performance. Females tend to have lower self-confidence and are more likely to experience stereotype threat, impacting their math performance. This refers to the anxiety and fear of confirming negative stereotypes about one's group, leading to lower academic achievement. Furthermore, females may face social and cultural pressures that discourage them from pursuing or excelling in traditionally male-dominated fields such as mathematics. On the other hand, males may receive more encouragement and support in their pursuit of mathematics, which can contribute to their higher average scale scores. Males may also be more likely to take advanced math courses or participate in math-related extracurricular activities, providing additional opportunities for learning and skill development.

***The findings of the study pose an important question: "Will the gap between male and female math performance still exist even if we increase the mastery motivation of females?"***

While increasing the Mastery Motivation of female students may help improve their performance in mathematics, it may not entirely eliminate the gender gap in average scale scores. The gender differences in performance are influenced by various social and cultural factors, not solely based on Mastery Motivation. Thus, addressing the gender gap in mathematics performance requires a holistic approach that addresses the underlying societal and cultural factors that contribute to gender differences. This includes promoting equal access to resources and opportunities for both male and female students, addressing negative stereotypes and biases, providing support and encouragement to female students, and implementing inclusive teaching practices that cater to diverse learning styles and abilities.

In conclusion, gender is a complex construct that intersects with other identities, such as race, ethnicity, socioeconomic status, and sexual orientation. Therefore, efforts to address the gender gap in mathematics performance must consider these intersecting identities and their unique challenges and barriers. Addressing the gender gap in mathematics performance requires a comprehensive approach that considers social and cultural factors, promotes equal opportunities, and resources, and implements inclusive teaching practices.

**Implication**

The study implies that promoting mastery motivation alone may not eliminate the gender gap in average scale scores. Instead, a comprehensive approach is needed to address the underlying societal and cultural factors contributing to gender differences in math performance. Addressing the gender gap in mathematics performance requires a holistic approach considering intersecting identities and their unique challenges and barriers. Further research, such as a qualitative study using interviews or focus groups, may be needed to identify potential barriers to female students' performance in math.

**Limitations**

When interpreting the findings, it is important to consider the limitations of the research. For instance, the study only examines data from the National Assessment of Educational Progress (NAEP) math achievement outcomes for 2019, which may not represent all grade 12 students in the United States. Additionally, the study relies on self-reported student motivation data, which may be influenced by social desirability bias or inaccurate self-assessment. Moreover, the study does not explore other factors that may influence the gender gap in math performance, such as teaching quality, curriculum design, or school environment. The research also does not consider other factors that may impact students' math performance, such as their socioeconomic background, race, ethnicity, or cultural background. Another limitation is that the study only examines the relationship between mastery motivation, math achievement, and gender and does not investigate the causal mechanisms that may explain these relationships. Additionally, the effect size of the gender differences found in the study was small, which may limit the practical significance of the findings. Furthermore, the sample used in the study is another limitation, as it focuses only on grade 12 students, and the findings may not generalize to students in other grades or educational contexts.

Overall, while the research provides important insights into the relationship between students' motivation, math achievement, and gender, its limitations suggest that further research is needed to gain a more comprehensive understanding of the factors contributing to the gender gap in math performance.

**Recommendations for Future Research**

To deepen our understanding of the gender gap in math performance, there are several recommendations for further research based on the findings and limitations of the current study. One suggestion is to conduct additional tests, such as qualitative studies using interviews or focus groups, to explore the experiences and perceptions of female and male students in math. This may help identify potential barriers to female students' performance in math, such as stereotype threats, implicit biases, or differences in problem-solving strategies.

Longitudinal studies that track students' math performance and motivation over time could also be conducted to understand better the development of gender differences in math performance and motivation. Additionally, investigating the impact of different interventions or programs to improve female students' math performance could help identify effective strategies for reducing the gender gap in math performance. Comparing math performance and motivation across different countries or cultures may also be beneficial in identifying factors that may be unique to the United States or other countries. Furthermore, investigating the role of intersectionality, such as the intersection of gender and race or socio-economic status, on math performance and motivation would help better understand how multiple identities may influence math performance and motivation.


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By addressing these gaps in the current research, we can better understand the factors that contribute to the gender gap in math performance and develop more effective strategies for promoting gender equity in math education.

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