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Math Anxiety and Math Self-Efficacy: How Demographic Variables Shape the Relationship

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ABSTRACT

The complex relationship between math anxiety and math self-efficacy (i.e. math dispositions) is well documented in educational psychology; however, while age and gender have been examined extensively, fewer studies have explored how a broader range of demographic factors collectively shape this association across student populations. This study aims to fill this gap by investigating how demographic factors (i.e., gender, age, race/ethnicity, first-generation status, and income level during childhood) influence the relationship between math anxiety and math self-efficacy. The participants completed an online survey that included math anxiety and math self-efficacy measures, as well as an extensive demographic questionnaire. The expected negative relationship between anxiety and efficacy was replicated and clear. This association was moderated by the participants' self-reported ethnicity, such that the relationship was stronger for Latine students, multiethnic students, and unreported ethnicity students. However, despite the common finding that women report more negative math dispositions, no relationship with gender emerged when additional dispositional factors were taken into account.These findings suggest the importance of considering demographic factors in mathematical outcomes and underscore the need for targeted interventions for students and DEI training for educators. Specifically, educational strategies should be designed to cater to the unique needs of these demographic groups.

Keywords: Math Anxiety; Math Self-Efficacy; Ethnicity; Math Dispositions; Demographics

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1. Introduction

Mathematical competency is the ability to understand, use, and apply math skills and concepts to solve problems in everyday and academic situations and is increasingly vital in today's educational and professional environments, where science, technology, and communications require a strong understanding of mathematical skills [1]. While mathematical competence relies on knowledge and skills, critical yet hidden personal factors also influence math learning and outcomes. One such personal factor is a learner's mathematical dispositions [2,3], the tendency to view mathematics as useful, worthwhile, and valuable, while possessing productive attitudes (e.g., high confidence, growth mindset) toward math [4]. Students who have productive mathematical dispositions (i.e., they have positive attitudes toward math, see value in math, and show interest in math) typically have higher performance, learning, and outcomes than those with unproductive math dispositions [5–8].

Math anxiety (MA), characterized by apprehension and fear while thinking about or engaging with mathematical tasks [9], is a dispositional factor that has garnered significant attention in educational research because of its adverse effects on math performance and choices related to career [10]. Individuals with high levels of MA often exhibit lower levels of math self-efficacy (MSE), which is the belief or confidence in one's ability to perform math tasks successfully. While the relationship between these dispositional factors of MA and MSE is well-established, the role of individual differences (e.g., demographic attributes) is understudied, because of social factors such as stereotypes, systemic racism, and access to resources, personal demographic factors may influence individuals' experiences of MA and MSE. Thus, the purpose of this study is to explore the impact of demographic variables to better understand the relationship between MA and MSE, potentially contributing to the development of educational interventions to support students from varying backgrounds.

1.1. Math Anxiety

While many people report disliking math [9], MA goes beyond disliking math and instead is a fear-based reaction to mathematics with thoughts, behaviors, and emotions similar to other types of anxiety [11,12]. Generally, MA is described as feelings of nervousness, apprehension, insecurity, or general discomfort when thinking about or engaging with mathematical problems [9,13,14] and can arise irrespective of actual math ability or knowledge [15]. Often beginning in early childhood [16] or primary grades [17], it regularly continues through formal educational settings [12] and may last into adulthood [18,19].

Individuals with high levels of MA tend to have aversions toward math-related situations and often avoid them, including required and elective courses, assignments, instructors, college majors, and career paths [20–23]. They also face challenges in maintaining positive attitudes toward mathematics and their own abilities, struggling with feelings of apprehension and self-doubt [13,24,25]. Individuals with high levels of MA experience neural activation in brain regions associated with pain when they think about doing math [26], and this heightened arousal generally affects an individual's performance or task efficiency [27,28] in part through reduced working memory capacity and cognitive processing efficiency [9,13,18,21,29,30]. Decreased math performance and high levels of MA often result in a cyclical process of avoidance, decreased learning, continued lower performance, and ongoing high MA [21]. Another contributing factor to lower performance in highly MA individuals is the dispositional factor of self-efficacy, which plays a significant role in the expression and impact of MA [12,17,25,31–35].

1.2. Self-Efficacy

Self-efficacy is an individual's belief in their ability to successfully execute a particular task [36,37]. Notably, self-efficacy is context-specific, varying across tasks and domains [38], which implies learners from different demographic backgrounds can indeed demonstrate varying levels of self-efficacy across academic disciplines, shaped by cultural, social, educational, and personal factors [39–41]. Students with higher levels of self-efficacy tend to perceive themselves as being in an optimal state for learning [42], demonstrate greater resilience and persistence in the face of challenges, and achieve better academic outcomes [30]. High self-efficacy is also associated with heightened motivation and positive expectations for success [43], whereas lower levels of self-efficacy can lead to increased anxiety [44], highlighting the intricate interplay between self-efficacy and emotional states.

Specifically, mathematics self-efficacy (MSE), defined as one's belief or confidence in one's ability to perform math tasks successfully, has been consistently linked to math achievement [17,45,46] and plays a crucial role in shaping individuals' attitudes and achievements in mathematics and related disciplines [13,34,47]. Individuals with high self-efficacy typically have greater math motivation [39] and, as such, engage in behaviors that are likely to lead to success, such as setting appropriate goals [48,49], persisting in solving math problems [46], and having more positive attitudes toward mathematics [50]. However, individuals with low MSE typically have higher MA [17,25,30,32,51,52] and can engage in behaviors that can lead to less productive outcomes, such as not setting goals, not persisting, and avoiding math classes and materials [53]. In this manuscript, self-efficacy refers specifically to task-focused beliefs about one's capability to perform a given activity [38], whereas expectations for success reflect broader anticipatory judgments about likely performance outcomes, consistent with expectancy-value framework is important for understanding how participants' beliefs about their abilities interact with their broader motivational orientations [54]. Recently, researchers have explored the mediating role of MSE in the relationship between MA and math performance and have consistently reported that MSE mediates this relationship [15,25,32,53].

Understanding the relationships between MA, MSE, and outcomes (e.g., learning, choice in major) is crucial for developing effective, targeted interventions in educational settings [30,32,34]. However, individual differences likely play a role in the expression of and relationships between these dispositional variables. For example, gender has frequently been studied in relation to these variables, particularly given the dearth of women in STEM disciplines and careers [54–56], with women typically reporting higher MA and lower MSE. While other individual differences in demographic factors have not typically been explored in MA or MSE, stereotype threat literature [57,58] and evidence from discipline-based education researchers in STEM [54] identify race or ethnicity as important demographic factors to consider in relation to mathematical dispositions. The literature on stereotype threat further suggests that other groups in which intelligence, ability, or academic success stereotypes exist may also exhibit important individual differences.

1.3. Individual Demographic Differences in MA and MSE

1.3.1. Gender

Despite a lack of consistent performance differences between men and women in mathematics [59,60], U.S. culture often perpetuates the stereotype of mathematics as a masculine discipline [57]. This stereotype is reinforced in educational settings, where male students are frequently provided with more access to and opportunities in math compared to female students. Research indicates that teachers' gender beliefs tend to favor males, which negatively impacts females' self-concept in math [61]. For instance, Lindner and colleagues [60] found that teachers' gender stereotypes contribute to differential encouragement and support for male and female students. In many countries, males generally do not outperform females, although there are exceptions where females perform equally well or better, and in most regions no significant differences are observed [61,62].

Alongside these performance-related findings, gender differences in MA have received extensive attention. Studies consistently report higher MA among women across self-report measures [13,63–68]. While MA is often linked to lower math performance, these gender differences in anxiety do not straightforwardly translate into lower math performance among women. Instead, the relationships among MA, math self-efficacy (MSE), and discipline or career interests appear to differ by gender. For example, Huang et al. (2019) reported that MSE strongly predicts male student STEM career interests, whereas MA more directly influences female students. Similarly, Akin and Kurbanoglu (2011) and Ahmed (2018) found gendered patterns in how dispositional factors shape interest and aspirations. More recently, Author (2024) reported that MSE predicts women's, but not men's, geoscience interest, while MA plays no significant role. Taken together, these findings suggest that gender differences in mathematics are shaped by a complex interplay of stereotypes, educational practices, competencies, and dispositional factors, warranting continued investigation.

Race/Ethnicity. Research on mathematical dispositions across racial and ethnic groups remains limited, but existing studies suggest significant disparities in learning experiences and outcomes. Black and Hispanic students often face systemic barriers that negatively impact their math self-efficacy and attitudes toward mathematics [69] and frequently encounter lower expectations from teachers, which can diminish their confidence and interest in the subject. Underserved minorities, particularly Black and Hispanic students, report higher levels of math anxiety compared to their peers [70]. Math self-efficacy plays a crucial role in mediating the relationship between math anxiety and performance across ethnicities [32,71]. However, the impact of prior math achievement on self-efficacy appears stronger for Hispanic students than for Caucasian students [71]. These negative dispositions are linked to broader socioeconomic factors and access to quality educational resources, and can particularly affect specific minority groups (e.g., Latine) [72]. Additionally, Hart and Ganley (2019) noted that stereotype threat can exacerbate MA among minority students, further hindering their performance and engagement. Culturally responsive teaching practices can mitigate some of these negative effects by affirming students' identities, fostering a more inclusive classroom environment [70], and helping teachers address their own biases to improve math dispositions among racially and ethnically diverse students [73].

1.3.2. Income/Social Class/SES

Socioeconomic status (SES) has been identified as a potential risk factor for negative math dispositions and achievement in some studies [74,75]. For example, living in a lower SES environment is often associated with fewer educational resources and support systems, which can negatively impact students' math performance and attitudes toward math. However, the relationship between SES and MA is complex, as cultural influences on SES can complicate its predictive power regarding MA [76]. For instance, in some cultural contexts, families with lower SES may emphasize perseverance, resilience, or collective support, which can buffer against high levels of math anxiety despite economic disadvantage [76]. Conversely, in other contexts, lower SES may coincide with limited access to quality instruction, fewer enrichment opportunities, or stigma that intensifies anxiety around mathematics. These cultural variations mean that SES does not uniformly predict MA across populations, highlighting the need to interpret findings within specific cultural and community contexts.

Additionally, SES was not found to be a significant predictor of math achievement in elementary school children, suggesting that other factors, such as gender, might influence the relationship between MA and performance [77]. Geist (2010) emphasized that children from lower SES backgrounds often face more significant challenges in math achievement due to limited access to quality educational resources and enrichment activities. Kalaycioglu (2015) also reported that SES can indirectly affect math performance through its impact on parental involvement and expectations, which are critical for developing a positive math self-concept and reducing MA.

Conversely, some studies indicate that the influence of SES on math achievement may be mediated by other variables, such as the school environment and instructional quality. Lau et al. (2022) suggested that cultural factors play a significant role in how SES impacts MA, highlighting the need for culturally responsive educational practices to address these disparities. Gender differences in MA and MSE further complicate the relationship between SES and math achievement. For example, Flowerdew (2021) reported that while SES was not a significant predictor of math achievement, MA influenced performance differently by gender, with females typically reporting higher levels of MA than males did. This finding aligns with broader research indicating that females often experience greater MA, which can negatively impact their math performance and self-efficacy [63,64]. The role of SES in math achievement and anxiety is multifaceted and influenced by various factors, including cultural context and gender.

1.3.3. Age

Researching age and MA yields conflicting findings, with some studies reporting no significant differences between traditional college-aged students and non-traditional students [78,79]. Additional research indicates that age effects of MA levels increase as students age [17,32]. Compared with their peers, adult learners and female students report higher levels of mathematics anxiety, indicating that female adult learners may be especially vulnerable [17,32]. This demographic's belief in their mathematics anxiety is crucial to understand, as many adult learners are routed into developmental mathematics courses, which often have low retention rates and decreased degree of completion.

The role of multiple demographic factors in understanding MA and MSE encompasses various dimensions beyond gender, including age, socioeconomic status (SES), and personal characteristics [12,80], an area that warrants further investigation.

1.4. Theoretical Framework

This study is grounded in two complementary theoretical perspectives: Expectancy–Value Theory (EVT) and Social Cognitive Theory (SCT), which together provide a robust framework for understanding the relationship between math anxiety and math self-efficacy, as well as the role of demographic factors in shaping these constructs. EVT posits that individuals' achievement-related behaviors are influenced by their expectations for success in a task and the value they attach to it [81]. Within the context of mathematics, students who expect to succeed and perceive math as valuable are more likely to engage with the subject, persist through challenges, and perform effectively. EVT also acknowledges that these expectancies and values are shaped by social and contextual factors, including prior experiences, cultural norms, and demographic characteristics. Applying EVT to our study allows us to examine how variations in students' expectations and perceived value of mathematics might mediate or moderate the relationship between math dispositions, particularly across diverse demographic student populations.

SCT emphasizes the role of self-efficacy beliefs in motivating behavior and regulating learning [36]. According to SCT, self-efficacy affects choice, effort, persistence, and emotional responses to challenges. In mathematics, students with higher math self-efficacy are more likely to approach difficult problems confidently, manage anxiety effectively, and sustain engagement. SCT also highlights the reciprocal interaction between personal, behavioral, and environmental factors, which aligns with our focus on demographic variables as potential moderators of the MA–MSE relationship.

By integrating EVT and SCT, this study situates math dispositions within a framework that considers both beliefs about competence and motivational expectancies, as well as the broader social and contextual influences that shape learning outcomes. EVT provides insight into how expectations and task value drive engagement and achievement, while SCT emphasizes the central role of self-efficacy in regulating behavior and emotional responses. Together, these frameworks provide a strong conceptual rationale for examining how demographic factors moderate the MA–MSE relationship, enriching the interpretive depth of our analysis and informing our understanding of structural and experiential influences on mathematics learning.

1.5. Current Study

While some demographic factors have been explored in relation to math anxiety (MA), other factors such as first-generation college status and childhood income level, have often been overlooked [81]. The current study seeks to address these gaps by using self-reported data on MA, MSE, and multiple demographic identities. Conditional process analysis was used to understand which demographic factors moderate the relationship between MA and MSE in undergraduate and graduate students. Our research addresses two questions:

1. To what extent does MA predict MSE in students, and does this relationship replicate established findings within contemporary higher education contexts?

   H1. *It is hypothesized that MA will be negatively associated with MSE, such that higher MA predicts lower MSE.*

2. How do demographic factors (i.e., gender, age, race/ethnicity, first-generation college status, and childhood income level) shape the relationship between MA and MSE, and what do these moderating effects reveal about structural or experiential inequities in STEM-related confidence development?

   H2. *It is hypothesized that demographic characteristics (gender, age, race/ethnicity, first-generation college status, and childhood income level) will moderate the association between MA and MSE, such that the strength of this negative relationship differs across demographic groups.*

2. Materials and Methods

2.1. Participants and Power Analysis

An a priori power analysis was conducted via G*Power version 3.1.9.7 [82] for sample size estimation. Utilizing a significant criterion of $\alpha = 0.05$ and power = 0.95, the minimum sample size needed with this effect size is N = 159. The sample for this study was drawn from a pool of undergraduate and graduate students at a medium-sized university in the western United States. Data were collected from 393 undergraduate, graduate students, and non-degree seeking students at a Rocky Mountain region university and were mainly recruited from introductory psychology and graduate statistics courses. The participants were given course credit or extra credit for the completion of the maximum 30-minute Qualtrics survey in which they completed a MA scale, MSE scale, and demographic questions in random order. Participants were drawn from three sources: introductory psychology courses, graduate statistics courses, and a general population sample. These datasets were combined to increase sample size and capture a broader range of experiences and demographic diversity. To account for potential differences across groups, all analyses included statistical controls for source sample, and group membership was examined as a covariate where relevant. This approach ensures that observed effects reflect relationships between math anxiety, math self-efficacy, and demographic factors rather than systematic differences between participant groups.

If the data were not complete, participant data were excluded (n = 172), leaving a sample of 221 participants completed the demographic portion, with a mean age of 19.23 years (SD = 4.11). Missing data were addressed using listwise deletion, excluding 172 incomplete cases; these cases were retained in a separate raw data file for transparency, and preliminary analyses indicated they did not differ systematically from included participants on key demographic variables. The sample represents a consolidation of multiple parallel studies investigating different samples [i.e., statistics major undergraduates (n = 100), psychology major undergraduates (n = 110), and graduate students university (n = 2), general population (n = 8)] that have been merged and collected over two years (see **Table 1** for the demographic characteristics. Participation was voluntary, with no prerequisites or compensation for involvement. Some participants may have received course credit in exchange for thirty minutes of participation.

Table 1. Demographic characteristics of the sample.

Variable	Category	Count	%
First Generation Status	No	137	62.0%
	Unsure	1	0.5%
	Yes	83	37.6%
Gender	Female	159	71.9%
	Male	61	27.6%
	Nonbinary or Questioning (3)	1	0.5%
Income Level	Under $20,000 Per Year	9	4.1%
	$20,000–$30,000 Per Year	23	10.4%
	$30,000–$40,000 Per Year	20	9.0%
	$40,000–$60,000 Per Year	43	19.5%
	$60,000–$80,000 Per Year	26	16.3%
	$80,000–$100,000 Per Year	34	15.4%
	$100,000–$150,000 Per Year	29	13.1%
	$150,000–$200,000 Per Year	12	5.4%
	$200,000–$250,000 Per Year	5	2.3%
	Above $250,000 Per Year	10	4.5%
International Student	No	196	88.7%
	Yes	25	11.3%
Race/Ethnicity	Asian	6	2.7%
	Black/African American	20	9.0%
	Hawaiian/Pacific Islander	47	21.3%
	Latine/Hispanic	28	12.7%
	Middle Eastern/North African	3	1.4%
	Native American/Indigenous	1	0.5%
	White	116	52.5%
Transgender Identity	No	218	98.6%
	Yes	2	0.9%
Parent A	Advanced Graduate Degree	43	19.5%
	Bachelor’s Degree	64	29.0%
	GED	11	5.0%
	High School Diploma	41	18.6%
	I Don’t Know	7	3.2%

Table 1. *Cont.*

Variable	Category	Count	%
Parent A	Less Than 12th Grade/No GED	13	5.9%
	Other	2	0.9%
	Prefer Not to Say	4	1.8%
	Some College	36	16.3%
Parent B	Advanced Graduate Degree	29	13.1%
	Bachelor's Degree	65	29.4%
	GED	13	5.9%
	High School Diploma	43	19.5%
	I Don't Know	9	4.1%
	Less Than 12th Grade and No GED	20	9.0%
	Other	2	0.9%
	Prefer Not to Say	6	2.7%
	Some College	34	15.4%
Year in School	First Year	104	47.1%
	Fourth Year	19	8.6%
	Graduate	2	0.9%
	Not Degree Completing	3	1.4%
	Other Degree Level Not Listed	5	2.3%
	Second Year	56	25.3%
	Third Year	32	14.5%

Note: N = 221. We did not have instances where individuals chose multiple racial or ethnic identities.

2.2. Measures

The *Abbreviated Math Anxiety Scale* (AMAS)[83] was used to measure self-reported MA. This nine-item Likert-type scale (1 = low anxiety, 5 = high anxiety) prompts participants to rate items in terms of how anxious they would be during mathematical events (e.g., "watching a teacher work an algebraic equation on the blackboard" and "thinking about an upcoming math test one day before"). The scores are summed (range = 9–45), with higher scores indicating higher mathematics anxiety (>33) and low scores indicating low math anxiety (<21). Hopko et al. (2003) reported excellent internal consistency (Cronbach's α = 0.90) and test-retest reliability (r = 0.085 over a 2-week period) of the AMAS; validity has also been established through correlation with a longer MA measure (r = 0.85). Prior to conducting any inferential statistics, the internal consistency reliability (α) was tested for the AMAS, which reported excellent internal consistency (Cronbach's α = 0.87).

The *Math Self-Efficacy Scale* (MSES)[84] was used to measure math self-efficacy. This nine-item Likert-type scale (1 = not at all confident, 5 = very confident) asks participants to estimate their confidence in their ability to complete specific academic math tasks (e.g., "work with decimals" or "determine the degree of a missing angle"). The responses are summed (range = 9–45); higher scores indicate higher levels of MSE. The MSE has both strong internal consistency reliability (Cronbach's α = 0.93) and validity as demonstrated by relationships with students' past math grades, scores on an established math self-concept measure, and students' expected math grades[84]. The MSES also reported excellent internal consistency (Cronbach's α = 0.88).

The demographic questionnaire included 10 multiple-choice and open-ended questions. The participants were asked to self-report their gender identity, age, degree type, parental education level (parents depicted as A and B), race/ethnic identity, and other relevant demographic information. The participants were allowed to choose not to respond to any demographic questions, and all the items included both "my identity is not represented" and "I choose not to answer".

2.3. Data Analysis

Face validity of the combined measures was tested in a small group of 3 graduate students who tested the questionnaire prior to data collection. After self-report data were collected on Qualtrics, the dataset was cleaned in Excel. Data analysis proceeded in SPSS in three stages: (a) descriptive statistics and bivariate correlations, (b) chi-square analyses, and (c) indirect effects testing.

3. Results

3.1. Descriptive Statistics and Correlations

Correlations and descriptive statistics of continuous variables are reported in **Table 2** below. The expected negative correlation between MA and MSE was significant, showing that participants with higher levels of self-reported MA had lower levels of self-reported MSE (r (221) = −0.49, p = 0.001). In a simple linear regression predicting MSE from MA, the standardized regression coefficient mirrored the correlation ($\beta = -0.49$, $p < 0.001$), and MA accounted for approximately 24% of the variance in MSE ($R^2 = 0.24$). These results confirm the strong inverse relationship between MA and MSE in this sample.

Table 2. Descriptive Statistics and Bivariate Correlations for Math Dispositions.

	AMAS	MSES
AMAS	1	
MSES	−0.49 **	1
Mean	27.99	27.95
SD	7.66	7.92
Skew	0.122	−0.054
Kurtosis	−0.41	−0.25

Note: ** $p < 0.01$.

3.2. Variable Selection

To determine the influence of each demographic factor (i.e., gender, socioeconomic status, first-generation status, racial and ethnic identity, and parental educational level) on the MA and MSE variables, a series of chi-square tests were conducted with all the demographic variables. As shown in **Table 3**, degree type (undergraduate freshman, undergraduate sophomore, undergraduate junior, undergraduate senior, graduate student, degree type not listed, not working toward degree completion) and ethnicity significantly differed in MA scores. MA scores were dichotomized using established cutoffs to create high- and low-anxiety groups, allowing for the examination of associations with categorical variables using chi-square tests. This analysis found that degree type and parental education level (parent B) significantly differed in MSE scores.

Table 3 displays key relationships between MA score variation, ethnicity, and degree type. MSE score variances related to differences between groups for degree type and parental education level (parent B). These data suggest that ethnicity, degree type, and parental education level (parent B) could moderate the expected negative direct effect relationship between MA and MSE. There were no statistically significant relationships with the expected variables, such as gender or SES, for either MA or self-efficacy, which resulted in these variables being omitted from the moderation analysis.

As a result of the statistically significant differences in the chi-square analyses, we conducted indirect effects analyses using Hayes conditional process analysis [85] using both processes 1 and 4 for their respective analyses. A moderation analysis was performed separately to determine whether the three statistically significant variables (ethnicity, degree type, and parental education level [parent B]) individually influenced the MA and MSE relationships via Hayes process model number 1. As expected, the direct effect of MA on MSE displayed a significant, negative relationship (R^2 = 0.26, β = 1.55, CI = [0.33, 2.78]). This direct effect was moderated by self-reported race/ethnicity, with some groups reporting particularly strong relationships between MA and MSE. Specifically, the relationship is strongest for individuals who self-reported more than one race or ethnicity (CI = [−0.67, −0.42]), who elected not to report their race/ethnicity (CI = [−0.75, −0.45]), and for those who self-reported as Hispanic, Latin, or Spanish in origin (CI = [−0.50, −0.16]). This suggests that for participants in these historically excluded racial/ethnic groups, the effect of their MA on their MSE is stronger than for participants in other groups.

Students' current degree type did not moderate the relationship between MA and MSE (R^2 = 0.24, β = 0.44, CI = [−1.94, 2.82]). This finding aligns with previous research indicating that educational attainment often exerts a direct influence on economic outcomes rather than interacting with other socioeconomic variables [86,87]. Degree type, in this context, refers to the highest level of education completed by the participant, categorized into undergraduate, graduate, and professional degrees. The theoretical basis for including degree type stems from socioeconomic theories that posit that educational attainment is a crucial determinant of financial and career success [86]. However, our results suggest that the moderating effect of degree type on the relationship between MA and MSE is not significant, indicating that the influence of MA on MSE remains consistent across different levels of educational attainment.

Table 3. Chi-square Summary of all Categorical Variables for Demographic Moderators.

	Categorical Variable	***df***	***n***	***χ2***	***p***
AMAS	Degree Type	210	221	264.15	0.01 *
	Ethnicity	210	221	447.32	<0.001 *
	First-generation	70	221	46.73	0.99
	Gender	70	221	47.99	0.98
	Income During Childhood	315	221	320.42	0.41
	International Status	35	221	46.77	0.09
	Parent A Education Level	280	221	254.52	0.86
	Parent B Education Level	280	221	306.16	0.14
	Transgender	70	221	63.61	0.69
MSES	Degree Type	210	221	266.04	<0.01 *
	Ethnicity	210	221	201.25	0.66
	First-generation	70	221	74.88	0.32
	Gender	70	221	65.78	0.62
	Income During Childhood	315	221	305.34	0.64
	International Status	35	221	38.08	0.33
	Parent A Education Level	280	221	256.69	0.84
	Parent B Education Level	280	221	335.77	0.01 *
	Transgender	70	221	54.45	0.92

Note: * $p < 0.05$.

Similarly, parent B's status ($R^2 = 0.24$, $\beta = 1.48$, *CI* = [−0.40, 3.37]) was examined to understand its potential role as a moderating variable. In our study, parent B's status refers to the employment and income level of the second parent or guardian. The decision to include this variable was informed by socioeconomic models that emphasize the cumulative impact of household income on educational and occupational outcomes [88]. However, using only one parent's income as a variable might have skewed the results due to inconsistencies in reporting. Participants with a single parent or missing data for parent B could have introduced bias, as zeros were imputed for absent data, potentially inflating the significance of this predictor. Therefore, while our chi-square analysis suggested initial significance, it is essential to interpret these findings with caution and consider the limitations of using incomplete data for parent B's status.

4. Discussion

The purpose of the current study was to explore the moderating effects of demographic factors on the indirect effects of MA on MSE. As expected, this indirect effect of MA on MSE was significant, which aligns with prior research [33,35]. The most significant finding was that race/ethnicity emerged as the sole demographic factor that moderated this relationship, with the interaction becoming stronger for multiracial, non-identified race/ethnicity, and Latine students. This finding is particularly important, as Cho and Kongo (2023) report that underserved ethnic minorities have been largely neglected in research on math attitudes, although students from underrepresented backgrounds typically underperform in mathematics compared with their white counterparts [89,90]. Given societal biases and stereotypes about mathematical ability in racial/ethnic minority students [73], it is possible that these performance differences are at least partly influenced by the internalized and unproductive mathematics dispositions held by members of these groups.

Interestingly, the direct effect of MA on MSE was not influenced by gender in the current study. While research provides significant evidence that women typically self-report both higher levels of MA and lower levels of MSE than men do [91], minimal research has explored how gender differences moderate the relationship between multiple dispositional factors [92]. Previous research does clearly argue that gender can affect other math-related factors. Huang and colleagues (2018) reported differential effects of dispositional factors on middle school males' and females' career interest, and Lent and colleagues [50] reported that women and men differed in their statements of factors influencing their MSE. Other research has indicated that gender differences in MA may not be significant when controlling MSE [93]. Clearly, the role of gender in math dispositions is complex and warrants further study. Several strengths contribute significantly to the existing body of research, including a focus on Hispanic-Serving Institution (HSI) status, which aligns with national efforts to increase the representation of Latine individuals in higher education. This focus provides valuable insights into the potential barriers to and facilitators of the entry and retention of Latine students in STEM fields.

Our research adds to the discourse on equity in education by examining the relationship between demographic factors and math-related variables such as anxiety and self-efficacy, particularly highlighting the moderating effect of ethnicity. This contribution is crucial, as it underscores the importance of culturally responsive educational practices and policies and has practical implications for supporting students' math learning across diverse populations. Implementing culturally responsive teaching strategies, such as connecting math content to students lived experiences and providing equitable opportunities for participation, may help reduce math anxiety and enhance math self-efficacy. Educators who consider demographic differences and create inclusive learning environments can foster greater confidence and engagement in mathematics, ultimately promoting more equitable outcomes. Our research adds to the discourse on equity in education by examining the relationship between demographic factors and math-related variables such as anxiety and self-efficacy, particularly highlighting the moderating effect of ethnicity. This contribution is crucial, as it underscores the importance of culturally responsive educational practices and policies.

4.1. Limitations

While our study provides valuable insights into the dynamics of MA and MSE, it is essential to acknowledge several limitations. First, the data were collected from only one university in the western United States, which may restrict the generalizability of our findings to other regions or educational settings and may limit the external validity of the findings. Expanding the study to include multi-institutional datasets would increase the diversity of participants, enhance the robustness of the results, and allow for greater confidence in generalizing the conclusions to broader populations. Our sample primarily consisted of undergraduate students, potentially not representing the experiences of individuals from a broader age range or diverse educational backgrounds. Expanding the study to include multi-institutional datasets would increase the diversity of participants, enhance the robustness of the results, and allow for greater confidence in generalizing the conclusions to broader populations. Additionally, our reliance on self-reported measures can introduce biases such as social desirability or inaccurate self-assessment. Using only one parent's income as a variable may have skewed our results due to inconsistencies in reporting, as some participants may have reported only one parent's income, and zeros imputed for absent data could artificially inflate significance. Future research should aim to collect comprehensive data from both parents to ensure a more accurate analysis.

However, these limitations may also offer valuable insights into the evolving trends toward equity within the educational landscape of the Rocky Mountain region. As highlighted earlier, the role of demographic variables in influencing MA and MSE remains subject to mixed findings in the literature. Our study contributes novel data to this discourse by examining the relationships between demographic factors and math variables such as anxiety and self-efficacy, with particular support for the moderating effect of ethnicity. Another limitation is the reliance on self-reported measures, which can be subject to biases such as social desirability or inaccurate self-assessment. Future research should aim to include a more diverse and representative sample and utilize a mix of qualitative and quantitative methods to triangulate findings and mitigate potential biases. Furthermore, longitudinal studies could provide deeper insights into how MA and MSE evolve over time and in different educational contexts.

Therefore, future research endeavors should aim to investigate diverse populations, including individuals from various academic disciplines and educational levels, to increase the generalizability and applicability of findings across broader contexts. Additionally, future research should consider longitudinal designs to track changes in MA and MSE over time and across different educational stages. Exploring the impact of various instructional strategies and interventions on reducing MA and enhancing self-efficacy in diverse demographic groups would provide further insights [94]. Expanding the geographical scope beyond the Rocky Mountain region to include other regions in the U.S. and international contexts could offer a more comprehensive understanding of the global applicability of our findings. By addressing these areas, future studies can build on our work to develop more inclusive and effective educational practices that mitigate MA and bolster MSE for all students. This work aligns with previous studies that emphasize the importance of self-regulatory strategies, particularly in middle school years, as a precursor to more cognitively demanding mathematics challenges in secondary and collegiate coursework [94]. As such, ongoing support for diverse student populations through dynamic instructional activities, self-regulatory practices, and consistent interactions with educators is essential for fostering a more equitable educational landscape [95].

4.2. Implications

Our findings have important implications for educational practice and intervention strategies. Recognizing the inverse relationship between MA and MSE highlights the need for targeted interventions that address math anxiety to increase students' confidence in their mathematical ability [30]. Given that ethnicity significantly moderates this relationship, developing culturally responsive strategies that address the specific needs of different ethnic groups is essential. For example, the pronounced negative impact of MA on MSE among individuals of Hispanic, Latine, or Spanish origin, as well as among those of multiethnic or racial origins, suggests that interventions should be tailored to these groups' unique experiences and cultural backgrounds. A notable limitation of this study is the unbalanced racial/ethnic composition of the sample, with 52.5% of participants identifying as White and only 12.7% identifying as Latine. This disproportion may have influenced the moderation results, as smaller subgroup sizes can reduce statistical power and increase variability in estimates for underrepresented groups. Consequently, caution is warranted when generalizing the findings to more diverse populations, and future research should aim to recruit more balanced samples to better examine the effects of race/ethnicity on the relationship between math anxiety and math self-efficacy. Understanding the moderating role of ethnicity can help educators tailor support systems to better meet the needs of diverse student populations. By considering the unique challenges faced by students from different ethnic backgrounds, interventions can be more effectively designed to mitigate the negative impact of math anxiety and enhance math self-efficacy, ultimately leading to improved mathematical learning outcomes.

Educators and policymakers should consider incorporating culturally relevant pedagogies and support systems that acknowledge and address the diverse ways in which mathematical anxiety manifests and affects students from different ethnic backgrounds [96,97]. Reducing mathematical anxiety can significantly improve mathematical self-efficacy, thereby enhancing students' overall academic performance and persistence in STEM fields [98]. Effective interventions include math anxiety workshops, peer tutoring, and mentorship programs focused on building confidence and reducing anxiety. Future research should explore the mechanisms through which ethnicity moderates the MA to MSE relationship to tailor interventions effectively and consider longitudinal studies to examine how changes in MA and MSE affect academic and career outcomes [99]. Addressing mathematical anxiety through culturally responsive interventions is crucial for improving educational outcomes, particularly for ethnic groups disproportionately affected by mathematical anxiety, and creating inclusive learning environments that foster success for all students.

5. Conclusions

This study provides significant insights into the moderating effects of demographic factors on the relationship between MA and MSE. Our analysis revealed a pronounced negative direct effect of MA on MSE, consistent with existing literature. Notably, this relationship was significantly moderated by ethnicity, with stronger effects observed among students identifying as multiracial, those who did not report their race/ethnicity, and those of Hispanic, Latin, or Spanish origin. The results underscore the importance of considering demographic factors in educational research and practice. The findings suggest a critical need for targeted interventions and culturally responsive educational strategies to address the unique challenges faced by these groups. Future research should aim to address the limitations of this study, such as the reliance on self-reported data and the geographically limited sample, by incorporating more diverse and representative samples and employing longitudinal designs. Additionally, exploring the mechanisms through which ethnicity moderates the MA-MSE relationship could further enhance the development of effective interventions. Overall, this study contributes to the discourse on equity in education by highlighting the significance of demographic factors in moderating the relationship between MA and MSE, emphasizing the need for tailored support to improve educational outcomes for all students.

Author Contributions

All authors contributed to the study conception and design. Material preparation, data collection, and analysis were performed by C.B.A. The manuscript was drafted by C.B.A in collaboration with C.S., J.E.L., and M.M.J., and all authors provided feedback on previous versions. Conceptualization: C.B.A., M.M.J.; Methodology: C.B.A.; Formal Analysis: C.B.A.; Writing—Original Draft: C.B.A.; Writing—Review & Editing: C.B.A., C.S., J.E.L., M.M.J.; Supervision: J.E.L., M.M.J.; Project Administration: C.B.A. All authors read and approved the final version of the manuscript.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board (or Ethics Committee) of University of Northern Colorado (protocol code 2112034030 approved 02/04/2022).

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Data Availability Statement

Data is unavailable due to privacy and ethical restrictions.

Conflicts of Interest

The authors declare no conflict of interest.

References

[1] Enderson, M.C., Ritz, J., 2016. STEM in General Education: Does Mathematics Competence Influence Course Selection. Journal of Technology Studies. 42(1), 30–40. DOI: https://doi.org/10.21061/jots.v42i1.a.3

[2] Awofala, A.O., Lawal, R.F., Arigbabu, A.A., et al., 2022. Mathematics Productive Disposition as a Correlate of Senior Secondary School Students' Achievement in Mathematics in Nigeria. International Journal of Mathematical Education in Science and Technology. 53(6), 1326–1342. DOI: https://doi.org/10.1080/0020739X.2020.1815881

[3] Kusmaryono, I., Suyitno, H., Dwijanto, D., et al., 2019. The Effect of Mathematical Disposition on Mathematical Power Formation: Review of Dispositional Mental Functions. International Journal of Instruction. 12(1), 343–356. DOI: https://doi.org/10.29333/iji.2019.12123a

[4] National Research Council, 2001. Adding It Up: Helping Children Learn Mathematics. National Academies Press: Washington, DC, USA. DOI: https://doi.org/10.17226/9822

[5] Ames, C., Archer, J., 1988. Achievement Goals in the Classroom: Students' Learning Strategies and Motivation Processes. Journal of Educational Psychology. 80(3), 260–267. DOI: https://doi.org/10.1037/0022-0663.80.3.260

[6] Cobb, P., Hodge, L.L., 2002. A Relational Perspective on Issues of Cultural Diversity and Equity as They Play Out in the Mathematics Classroom. Mathematical Thinking and Learning. 4(2–3), 249–284. DOI: https://doi.org/10.1207/S15327833MTL04023_7

[7] Kilpatrick, J., 2001. Understanding Mathematical Literacy: The Contribution of Research. Educational Studies in Mathematics. 47(1), 101–116. DOI: https://doi.org/10.1023/A:1017973827514

[8] Siegfried, J.Z.M., 2012. The Hidden Strand of Mathematical Proficiency: Defining and Assessing for Productive Disposition in Elementary School Teachers' Mathematical Content Knowledge [PhD Thesis]. University of California: San Diego, CA, USA.

[9] Ashcraft, M.H., Kirk, E.P., 2001. The Relationships Among Working Memory, Math Anxiety, and Performance. Journal of Experimental Psychology: General. 130(2), 224–237. DOI: https://doi.org/10.1037/0096-3445.130.2.224

[10] Eidlin-Levy, H., Avraham, E., Fares, L., et al., 2023. Math Anxiety Affects Career Choices During Development. International Journal of STEM Education. 10(1), 49. DOI: https://doi.org/10.1186/s40594-023-00441-8

[11] Rosenfeld, H., 1978. Notes on the Psychopathology and Psychoanalytic Treatment of Some Borderline Patients. The International Journal of Psychoanalysis. 59(2–3), 215–221.

[12] Luttenberger, S., Wimmer, S., Paechter, M., 2018. Spotlight on Math Anxiety. Psychology Research and Behavior Management. 11, 311–322. DOI: https://doi.org/10.2147/PRBM.S141421

[13] Hembree, R., 1990. The Nature, Effects, and Relief of Mathematics Anxiety. Journal for Research in Mathematics Education. 21(1), 33–46. DOI: https://doi.org/10.5951/jresematheduc.21.1.0033

[14] Richardson, F.C., Suinn, R.M., 1972. The Mathemat-

ics Anxiety Rating Scale: Psychometric data. Journal of Counseling Psychology. 19(6), 551–554. DOI: https://doi.org/10.1037/h0033456

[15] Hoffman, B., 2010. "I Think I Can, but I'm Afraid to Try": The Role of Self-Efficacy Beliefs and Mathematics Anxiety in Mathematics Problem-Solving Efficiency. Learning and Individual Differences. 20(3), 276–283. DOI: https://doi.org/10.1016/j.lindif.2010.02.001

[16] Maloney, E.A., Ramirez, G., Gunderson, E.A., et al., 2015. Intergenerational Effects of Parents' Math Anxiety on Children's Math Achievement and Anxiety. Psychological Science. 26(9), 1480–1488. DOI: https://doi.org/10.1177/0956797615592630

[17] Jameson, M.M., Fusco, B.R., 2014. Math Anxiety, Math Self-Concept, and Math Self-Efficacy in Adult Learners Compared to Traditional Undergraduate Students. Adult Education Quarterly. 64(4), 306–322. DOI: https://doi.org/10.1177/0741713614541461

[18] Barroso, C., Ganley, C.M., McGraw, A.L., et al., 2021. A Meta-Analysis of the Relation Between Math Anxiety and Math Achievement. Psychological Bulletin. 147(2), 134–168. DOI: https://doi.org/10.1037/bul0000307

[19] Chipman, S.F., Krantz, D.H., Silver, R., 1992. Mathematics Anxiety and Science Careers among Able College Women. Psychological Science. 3(5), 292–296. DOI: https://doi.org/10.1111/j.1467-9280.1992.tb00675.x

[20] Ahmed, W., 2018. Developmental Trajectories of Math Anxiety During Adolescence: Associations with STEM Career Choice. Journal of Adolescence. 67(1), 158–166. DOI: https://doi.org/10.1016/j.adolescence.2018.06.010

[21] Ashcraft, M.H., Krause, J.A., 2007. Working Memory, Math Performance, and Math Anxiety. Psychonomic Bulletin & Review. 14(2), 243–248. DOI: https://doi.org/10.3758/BF03194059

[22] Huang, X., Zhang, J., Hudson, L., 2019. Impact of Math Self-Efficacy, Math Anxiety, and Growth Mindset on Math and Science Career Interest for Middle School Students: The Gender Moderating Effect. European Journal of Psychology of Education. 34(3), 621–640. DOI: https://doi.org/10.1007/s10212-018-0403-z

[23] Levy, H.E., Fares, L., Rubinsten, O., 2021. Math Anxiety Affects Females' Vocational Interests. Journal of Experimental Child Psychology. 210, 105214. DOI: https://doi.org/10.1016/j.jecp.2021.105214

[24] Gonzalez-DeHass, A.R., Furner, J.M., Vásquez-Colina, M.D., et al., 2024. Undergraduate Students' Math Anxiety: the Role of Mindset, Achievement Goals, and Parents. International Journal of Science and Mathematics Education. 22(5), 1037–1056. DOI: https://doi.org/10.1007/s10763-023-10416-4

[25] Palestro, J.J., Jameson, M.M., 2020. Math Self-Efficacy, Not Emotional Self-Efficacy, Mediates the Math Anxiety-Performance Relationship in Undergraduate Students. Cognition, Brain, Behavior. An interdisciplinary journal. 24(4), 379–394. DOI: https://doi.org/10.24193/cbb.2020.24.20

[26] Lyons, I.M., Beilock, S.L., 2012. Mathematics Anxiety: Separating the Math from the Anxiety. Cerebral Cortex. 22(9), 2102–2110. DOI: https://doi.org/10.1093/cercor/bhr289

[27] Derakshan, N., Eysenck, M.W., 2009. Anxiety, Processing Efficiency, and Cognitive Performance: New Developments from Attentional Control Theory. European Psychologist. 14(2), 168–176. DOI: https://doi.org/10.1027/1016-9040.14.2.168

[28] Teigen, K.H., 1994. Yerkes-Dodson: A Law for All Seasons. Theory & Psychology. 4(4), 525–547. DOI: https://doi.org/10.1177/0959354394044004

[29] Ma, X., 1999. A Meta-Analysis of the Relationship Between Anxiety Toward Mathematics and Achievement in Mathematics. Journal for Research in Mathematics Education. 30(5), 520. DOI: https://doi.org/10.2307/749772

[30] Ramirez, G., Shaw, S.T., Maloney, E.A., 2018. Math Anxiety: Past Research, Promising Interventions, and a New Interpretation Framework. Educational Psychologist. 53(3), 145–164. DOI: https://doi.org/10.1080/00461520.2018.1447384

[31] Jameson, M.M., 2020. Time, Time, Time: Perceptions of the Causes of Mathematics Anxiety in Highly Maths Anxious Female Adult Learners. Adult Education Quarterly. 70(3), 223–239. DOI: https://doi.org/10.1177/0741713619896324

[32] Jameson, M.M., Dierenfeld, C., Ybarra, J., 2022. The Mediating Effects of Specific Types of Self-Efficacy on the Relationship between Math Anxiety and Performance. Education Sciences. 12(11), 789. DOI: https://doi.org/10.3390/educsci12110789

[33] Sexton, J., London, D., Jameson, M.M., et al., 2022. Thriving, Persisting, or Agonizing: Integrated Math Anxiety Experiences of University Students in Introductory Geoscience Classes. Education Sciences. 12(9), 577. DOI: https://doi.org/10.3390/educsci12090577

[34] Jameson, M.M., Sexton, J., London, D., et al., 2024. Relationships and Gender Differences in Math Anxiety, Math Self-Efficacy, Geoscience Self-Efficacy, and Geoscience Interest in Introductory Geoscience Students. Education Sciences. 14(4), 426. DOI: https://doi.org/10.3390/educsci14040426

[35] Reyes, J.D.C., 2019. Mathematics Anxiety and Self-Efficacy: A Phenomenological Dimension. Journal of Humanities and Education Development. 1(1), 22–34. Available from: https://www.researchgate.net/publication/342589192_Mathematics_Anxiety_and_Self-Efficacy_A_Phenomenological_Dimension

[36] Bandura, A., 1989. Regulation of Cognitive Processes Through Perceived Self-Efficacy. Developmental Psy-

chology. 25(5), 729–735. DOI: https://doi.org/10.1037/0012-1649.25.5.729

[37] Bernacki, M.L., Nokes-Malach, T.J., Aleven, V., 2015. Examining Self-Efficacy During Learning: Variability and Relations to Behavior, Performance, and Learning. Metacognition and Learning. 10(1), 99–117. DOI: https://doi.org/10.1007/s11409-014-9127-x

[38] Bandura, A., 1997. Self-Efficacy: The Exercise of Control. Macmillan: London, UK.

[39] Pajares, F., 1996. Self-Efficacy Beliefs in Academic Settings. Review of Educational Research. 66(4), 543–578. DOI: https://doi.org/10.3102/00346543066004543

[40] Wilson, D.M., Bates, R., Scott, E.P., et al., 2015. Differences in Self-Efficacy Among Women and Minorities in STEM. Journal of Women and Minorities in Science and Engineering. 21(1), 27–45. DOI: https://doi.org/10.1615/JWomenMinorScienEng.2014005111

[41] Whitcomb, K.M., Kalender, Z.Y., Nokes-Malach, T.J., et al., 2020. A Mismatch Between Self-Efficacy and Performance: Undergraduate Women in Engineering Tend to Have Lower Self-Efficacy Despite Earning Higher Grades Than Men. arXive preprint. arXiv: 2003.06006. DOI: https://doi.org/10.48550/ARXIV.2003.06006

[42] Schweder, S., 2019. The Role of Control Strategies, Self-Efficacy, and Learning Behavior in Self-Directed Learning. International Journal of School & Educational Psychology. 7(sup1), 29–41. DOI: https://doi.org/10.1080/21683603.2018.1459991

[43] Schunk, D.H., 1996. Self-Efficacy for Learning and Performance. In Proceedings of the Annual Conference of the American Educational Research Association, New York, NY, USA, 8–12 April 1996. Available from: https://eric.ed.gov/?id=ED394663

[44] Usher, E.L., Pajares, F., 2009. Sources of Self-Efficacy in Mathematics: A Validation Study. Contemporary Educational Psychology. 34(1), 89–101. DOI: https://doi.org/10.1016/j.cedpsych.2008.09.002

[45] May, D.K., 2009. Mathematics Self-Efficacy and Anxiety Questionnaire [PhD Thesis]. University of Georgia: Athens, GA, USA. Available from: https://openscholar.uga.edu/record/16920

[46] Masitoh, L.F., Fitriyani, H., 2018. Improving Students' Mathematics Self-Efficacy Through Problem Based Learning. Malikussaleh Journal of Mathematics Learning (MJML). 1(1), 26. DOI: https://doi.org/10.29103/mjml.v1i1.679

[47] Ashcraft, M.H., Kirk, E.P., Hopko, D., 2021. On the Cognitive Consequences of Mathematics Anxiety. In: The Development of Mathematical Skills. Psychology Press: London, UK. pp. 174–196. DOI: https://doi.org/10.4324/9781315784755-11

[48] Schunk, D.H., 1989. Self-Efficacy and Cognitive Achievement: Implications for Students with Learning Problems. Journal of Learning Disabilities. 22(1), 14–22. DOI: https://doi.org/10.1177/002221948902200103

[49] Wang, X., Houang, R.T., Schmidt, W.H., et al., 2024. Relationship Between Opportunity to Learn, Mathematics Self-Efficacy, and Math Performance: Evidence from PISA 2012 in 63 Countries and Economies. International Journal of Science and Mathematics Education. 22(8), 1683–1708. DOI: https://doi.org/10.1007/s10763-024-10446-6

[50] Lent, R.W., Brown, S.D., Brenner, B., et al., 2001. The Role of Contextual Supports and Barriers in the Choice of Math/Science Educational Options: A Test of Social Cognitive Hypotheses. Journal of Counseling Psychology. 48(4), 474–483. DOI: https://doi.org/10.1037/0022-0167.48.4.474

[51] Akin, A., Kurbanoglu, I.N., 2011. The Relationships between Math Anxiety, Math Attitudes, and Self-Efficacy: A Structural Equation Model. Studia Psychologica. 53(3), 263. Available from: https://www.studiapsychologica.com/uploads/AKIN_SP_03_vol.53_2011_pp.263-273.pdf

[52] Meece, J.L., Wigfield, A., Eccles, J.S., 1990. Predictors of Math Anxiety and Its Influence on Young Adolescents' Course Enrollment Intentions and Performance in Mathematics. Journal of Educational Psychology. 82(1), 60–70. DOI: https://doi.org/10.1037/0022-0663.82.1.60

[53] Simamora, R.E., Saragih, S., Hasratuddin, H., 2018. Improving Students' Mathematical Problem Solving Ability and Self-Efficacy through Guided Discovery Learning in Local Culture Context. International Electronic Journal of Mathematics Education. 14(1). DOI: https://doi.org/10.12973/iejme/3966

[54] Kahn, S., Ginther, D., 2017. Women and STEM (No. w23525). National Bureau of Economic Research: Cambridge, MA, USA. DOI: https://doi.org/10.3386/w23525

[55] Heyder, A., Weidinger, A.F., Steinmayr, R., 2021. Only a Burden for Females in Math? Gender and Domain Differences in the Relation Between Adolescents' Fixed Mindsets and Motivation. Journal of Youth and Adolescence. 50(1), 177–188. DOI: https://doi.org/10.1007/s10964-020-01345-4

[56] Lake, V.E., Kelly, L., 2014. Female Preservice Teachers and Mathematics: Anxiety, Beliefs, and Stereotypes. Journal of Early Childhood Teacher Education. 35(3), 262–275. DOI: https://doi.org/10.1080/10901027.2014.936071

[57] Smeding, A., 2012. Women in Science, Technology, Engineering, and Mathematics (STEM): An Investigation of Their Implicit Gender Stereotypes and Stereotypes' Connectedness to Math Performance. Sex Roles. 67(11–12), 617–629. DOI: https://doi.org/10.1007/s11199-012-0209-4

[58] Thébaud, S., Charles, M., 2018. Segregation, Stereotypes, and STEM. Social Sciences. 7(7), 111. DOI:

https://doi.org/10.3390/socsci7070111

[59] Hyde, J.S., Fennema, E., Lamon, S.J., 1990. Gender Differences in Mathematics Performance: A Meta-Analysis. Psychological Bulletin. 107(2), 139–155. DOI: https://doi.org/10.1037/0033-2909.107.2.139

[60] Lindberg, S.M., Hyde, J.S., Petersen, J.L., et al., 2010. New Trends in Gender and Mathematics Performance: A Meta-Analysis. Psychological Bulletin. 136(6), 1123–1135. DOI: https://doi.org/10.1037/a0021276

[61] Bakker, M., Torbeyns, J., Verschaffel, L., et al., 2022. The Mathematical, Motivational, and Cognitive Characteristics of High Mathematics Achievers in Primary School. Journal of Educational Psychology. 114(5), 992–1004. DOI: https://doi.org/10.1037/edu0000678

[62] Stanford Graduate School of Education, 2018. New Stanford Education Study Shows Where Boys and Girls Do Better in Math and English. Available from: https://ed.stanford.edu/news/new-stanford-education-study-shows-where-boys-and-girls-do-better-math-english (cited 1 June 2025).

[63] Ashcraft, M.H., Faust, M.W., 1994. Mathematics Anxiety and Mental Arithmetic Performance: An Exploratory Investigation. Cognition & Emotion. 8(2), 97–125. DOI: https://doi.org/10.1080/02699939408408931

[64] Balogˇlu, M., Koçak, R., 2006. A Multivariate Investigation of the Differences in Mathematics Anxiety. Personality and Individual Differences. 40(7), 1325–1335. DOI: https://doi.org/10.1016/j.paid.2005.10.009

[65] Bernstein, J.D., 1992. Barriers to Women Entering The Workforce: Math Anxiety. Research Bulletin No. 3. New Jersey Equity Research Bulletin. Available from: https://eric.ed.gov/?id=ED359381

[66] Else-Quest, N.M., Hyde, J.S., Linn, M.C., 2010. Cross-National Patterns of Gender Differences in Mathematics: A Meta-Analysis. Psychological Bulletin. 136(1), 103–127. DOI: https://doi.org/10.1037/a0018053

[67] Hart, S.A., Ganley, C.M., 2019. The Nature of Math Anxiety in Adults: Prevalence and Correlates. Journal of Numerical Cognition. 5(2), 122–139. DOI: https://doi.org/10.5964/jnc.v5i2.195

[68] Wahid, S.N.S., Yusof, Y., Nor, A.H.M., 2018. Effect of Mathematics Anxiety on Students' Performance in Higher Education Level: A Comparative Study on Gender. In Proceedings of The 25th National Symposium on Mathematical Sciences (SKSM25): Mathematical Sciences as the Core of Intellectual Excellence, Pahang, Malaysia, 2018; p. 050010. DOI: https://doi.org/10.1063/1.5041710

[69] Casanova, S., Vukovic, R.K., Kieffer, M.J., 2021. Do Girls Pay an Unequal Price? Black and Latina Girls' Math Attitudes, Math Anxiety, and Mathematics Achievement. Journal of Applied Developmental Psychology. 73, 101256. DOI: https://doi.org/10.1016/j.appdev.2021.101256

[70] Cho, K.W., Kongo, D., 2024. The Relations Among Math Anxiety, Math Self-Construct, and Math Achievement in Older and Underserved Minority Students. The Journal of Continuing Higher Education. 72(2), 204–220. DOI: https://doi.org/10.1080/07377363.2023.2218580

[71] Stevens, T., Olivarez, A., Lan, W.Y., et al., 2004. Role of Mathematics Self-Efficacy and Motivation in Mathematics Performance Across Ethnicity. The Journal of Educational Research. 97(4), 208–222. DOI: https://doi.org/10.3200/JOER.97.4.208-222

[72] Perry, C., Sampson, S., Ayala-DiAz, M., 2023. Investigating Hispanic Preservice Teachers' Mathematics Anxiety, Attitudes, and Self-Efficacy. International Journal of Educational Studies in Mathematics. 10(3), 166–179. DOI: https://doi.org/10.17278/ijesim.1217360

[73] Copur-Gencturk, Y., Plowman, D., Bai, H., 2019. Mathematics Teachers' Learning: Identifying Key Learning Opportunities Linked to Teachers' Knowledge Growth. American Educational Research Journal. 56(5), 1590–1628. DOI: https://doi.org/10.3102/0002831218820033

[74] Geist, E., 2010. The Anti-Anxiety Curriculum: Combating Math Anxiety in the Classroom. Journal of Instructional Psychology. 37(1).

[75] Kalaycioglu, D.B., 2015. The Influence of Socioeconomic Status, Self-efficacy, and Anxiety on Mathematics Achievement in England, Greece, Hong Kong, the Netherlands, Turkey, and the USA. Educational Sciences: Theory & Practice. Educational Sciences: Theory and Practice, 15(5), 1391–1401. Available from: https://files.eric.ed.gov/fulltext/EJ1101308.pdf

[76] Lau, N.T.T., Hawes, Z., Tremblay, P., et al., 2022. Disentangling the Individual and Contextual Effects of Math Anxiety: A Global Perspective. Proceedings of the National Academy of Sciences. 119(7), e2115855119. DOI: https://doi.org/10.1073/pnas.2115855119

[77] Flowerdew, M., 2021. Demographic Predictors of Math Anxiety in Elementary School Children [Master's Thesis]. University of Northern Colorado: Greeley, CO, USA. Available from: https://digscholarship.unco.edu/theses/216

[78] Gabriel, M.H., Atkins, D., Chokshi, A., et al., 2019. Exploring Math Anxiety and Math Self-Efficacy Among Health Administration Students. The Journal of Health Administration Education. 36(2), 151–168. Available from: https://www.ingentaconnect.com/contentone/aupha/jhae/2019/00000036/00000002/art00003

[79] Woodard, T.S.H., 2002. The Effects of Math Anxiety on Postsecondary Developmental Students As Related to Achievement, Gender, and Age [PhD Thesis]. Argosy University Seattle: Seattle, WA, USA. Available from: https://files.eric.ed.gov/fulltext/EJ876845.pdf

[80] Jain, S., Dowson, M., 2009. Mathematics Anxiety as a Function of Multidimensional Self-Regulation and

Self-Efficacy. Contemporary Educational Psychology. 34(3), 240–249. DOI: https://doi.org/10.1016/j.cedpsych.2009.05.004

[81] Dowker, A., Sarkar, A., Looi, C.Y., 2016. Mathematics Anxiety: What Have We Learned in 60 Years? Frontiers in Psychology. 7. DOI: https://doi.org/10.3389/fpsyg.2016.00508

[82] Faul, F., Erdfelder, E., Lang, A.-G., et al., 2007. G*Power 3: A Flexible Statistical Power Analysis Program for the Social, Behavioral, and Biomedical Sciences. Behavior Research Methods. 39(2), 175–191. DOI: https://doi.org/10.3758/BF03193146

[83] Hopko, D.R., Mahadevan, R., Bare, R.L., et al., 2003. The Abbreviated Math Anxiety Scale (AMAS): Construction, Validity, and Reliability. Assessment. 10(2), 178–182. DOI: https://doi.org/10.1177/1073191103010002008

[84] Nielsen, I.L., Moore, K.A., 2003. Psychometric Data On The Mathematics Self-Efficacy Scale. Educational and Psychological Measurement. 63(1), 128–138. DOI: https://doi.org/10.1177/0013164402239321

[85] Hayes, A.F., 2012. PROCESS: A Versatile Computational Tool for Observed Variable Mediation, Moderation, and Conditional Process Modeling. Available from: https://is.muni.cz/el/1423/podzim2014/PSY704/50497615/hayes_2012_navod_process.pdf

[86] Becker, G.S., 1993. Human Capital: A Theoretical and Empirical Analysis, with Special Reference to Education. University of Chicago Press. DOI: https://doi.org/10.7208/chicago/9780226041223.001.0001

[87] Gorard, S., See, B.H., 2009. The Impact of Socio-Economic Status on Participation and Attainment in Science. Studies in Science Education. 45(1), 93–129. DOI: https://doi.org/10.1080/03057260802681821

[88] Lareau, A., 2018. Unequal Childhoods: Class, Race, and Family Life. In: Grusky, D.B., Hill, J. (Eds.). Inequality in the 21st Century. Routledge: London, UK. pp. 444–451. DOI: https://doi.org/10.4324/9780429499821-75

[89] Aud, S., Kewal Ramani, A., Frohlich, L., 2011. America's Youth: Transitions to Adulthood. National Center for Education Statistics: Washington, DC, USA. Available from: https://nces.ed.gov/pubs2012/2012026.pdf

[90] National Center for Education Statistics (NCES), n.d. District Student Group Scores and Score Gaps. National Center for Education Statistics: Washington, DC, USA. Available from: https://www.nationsreportcard.gov/math_2017/districts/gaps/?grade+=+8&grade=4

[91] Khasawneh, E., Gosling, C., Williams, B., 2021. What Impact Does Maths Anxiety Have on University Students? BMC Psychology. 9(1), 37. DOI: https://doi.org/10.1186/s40359-021-00537-2

[92] Wang, L., Yu, Z., 2023. Gender-Moderated Effects of Academic Self-Concept on Achievement, Motivation, Performance, and Self-Efficacy: A Systematic Review. Frontiers in Psychology. 14, 1136141. DOI: https://doi.org/10.3389/fpsyg.2023.1136141

[93] Hiller, S.E., Kitsantas, A., Cheema, J.E., et al., 2022. Mathematics Anxiety and Self-Efficacy as Predictors of Mathematics Literacy. International Journal of Mathematical Education in Science and Technology. 53(8), 2133–2151. DOI: https://doi.org/10.1080/0020739X.2020.1868589

[94] Cleary, T.J., Chen, P.P., 2009. Self-Regulation, Motivation, and Math Achievement in Middle School: Variations Across Grade Level and Math Context. Journal of School Psychology. 47(5), 291–314. DOI: https://doi.org/10.1016/j.jsp.2009.04.002

[95] Fan, X., Hambleton, R.K., Zhang, M., 2019. Profiles of Mathematics Anxiety Among 15-Year-Old Students: A Cross-Cultural Study Using Multi-Group Latent Profile Analysis. Frontiers in Psychology. 10, 1217. DOI: https://doi.org/10.3389/fpsyg.2019.01217

[96] Gay, G., 2018. Culturally Responsive Teaching: Theory, Research, and Practice, 3rd ed. Teachers College Press: New York, NY, USA.

[97] Ladson-Billings, G., 1995. Toward a Theory of Culturally Relevant Pedagogy. American Educational Research Journal. 32(3), 465–491. DOI: https://doi.org/10.3102/00028312032003465

[98] Beilock, S.L., Willingham, D.T., 2014. Math Anxiety: Can Teachers Help Students Reduce it? American Educator. 38(2), 28–32. Available from: https://www.aft.org/sites/default/files/beilock.pdf

[99] Wigfield, A., Eccles, J.S., 2000. Expectancy–Value Theory of Achievement Motivation. Contemporary Educational Psychology. 25(1), 68–81. DOI: https://doi.org/10.1006/ceps.1999.1015