education sciences

Article

The Mediating Effects of Specific Types of Self-Efficacy on the Relationship between Math Anxiety and Performance

Molly M. Jameson *, Celeste Dierenfeld and Julia Ybarra

The School of Psychological Sciences, University of Northern Colorado, Greeley, CO 80639, USA
* Correspondence: molly.jameson@unco.edu

Abstract: The negative relationship between math anxiety and math performance is well-supported in the literature. The important role of students' math self-efficacy (i.e., their confidence in their ability to successfully complete specific math tasks) in this relationship is also established. Self-efficacy is extremely specific, however, and it is possible that additional types of self-efficacy can play a role in the relationship between anxiety and performance. This study surveyed 118 undergraduate students on their math anxiety, math performance, math self-efficacy, emotional self-efficacy, and emotional self-efficacy specifically in math to determine the mediating effects of these specific types of self-efficacy. Hierarchical linear regression shows that math self-efficacy continues to fully mediate the relationship between anxiety and performance; in the current study, emotional self-efficacy partially mediated the relationship while emotional self-efficacy specifically in math did not. The role of emotional self-efficacy should be further explored, as these findings are contrary to previous work. Educational interventions should continue to emphasize building students' math confidence to improve the math performance of math-anxious students.

Keywords: math anxiety; math self-efficacy; emotional self-efficacy; mediation; undergraduate students

Citation: Jameson, M.M.; Dierenfeld, C.; Ybarra, J. The Mediating Effects of Specific Types of Self-Efficacy on the Relationship between Math Anxiety and Performance. *Educ. Sci.* **2022**, *12*, 789. https://doi.org/10.3390/educsci12110789

Academic Editor: Andras Balogh

Received: 29 August 2022
Accepted: 2 November 2022
Published: 5 November 2022

1. Introduction

Mathematics is a core academic discipline, particularly as STEM fields become more central to our workforce. A recent Gallup Poll [1] showed that Americans rated math as the most important subject they took in school. Math skills and knowledge are important to academic and career success. However, math skills and knowledge are not simply due to intelligence, effort, or motivation. The attitudes that students have toward math and toward themselves influence their math learning and performance [2–4]. Holding productive dispositions in mathematics refers to understanding math, perceiving it as useful and worthwhile, believing that effort leads to better learning, and holding positive attitudes toward mathematics (e.g., high confidence in one's ability to complete math problems; 5). Students with productive mathematical dispositions are more likely to learn mathematical skills and knowledge, earn better grades, and make choices in which they approach mathematics more than students with more unproductive dispositions toward mathematics [5–9]. However, mathematics is a discipline that many students hold unproductive dispositions toward [9,10]. Understanding these unproductive dispositions and associated negative attitudes can help one understand the nuances of how math attitudes affect math performance.

1.1. Math Anxiety

While many students dislike math, some students have more of an intense and fear-based reaction than dislike would entail. For these students with math anxiety, they experience worry, tension, and fear related to thinking about or doing math, and this math anxiety typically interferes with their ability to successfully perform math in both academic and everyday situations [2,3]. Though there is no generally agreed upon framework for math anxiety, most definitions and measurements of math anxiety include anxiety over taking math tests, anxiety in the math classroom, and numerical anxiety [11], though some also consider anxiety related to mathematics teachers [12]. While a distinct form of anxiety [13], it shares characteristics with other forms of anxiety, including physiological reactions (e.g., racing heart, sweaty palms), cognitive reactions (e.g., decreased working memory capacity, negative self-talk), emotional reactions (e.g., feeling “worried” or “afraid”), and behavioral reactions (e.g., procrastination) [2,11,14]. Math anxiety can be expressed as both a trait (i.e., enduring) and a state (i.e., in the moment) type of anxiety, as individuals with high math anxiety experience it as a habitual and stable characteristic that is aroused during situations in which mathematics is thought about or used ([13]). For students with high math anxiety, thinking about or doing math activates neural pain networks [15], suggesting that math is a threatening stimulus for these students. Not surprisingly, students with high math anxiety avoid math [16,17], including avoiding majoring in disciplines perceived as math-heavy [18,19]. Additionally, a gender difference typically exists in math anxiety, in which women tend to report higher levels of math anxiety than men do; however, this gender difference does not always translate to differences in math performance [20].

Students with high math anxiety often experience other negative dispositions toward math, including low math motivation, low math interest, and math avoidance, among others [21–23]. Recent work by Jameson and Allen [24] shows that students with high math anxiety are likely to also have strong avoidant personality temperaments, suggesting that they are avoidant in general, not only in math. Students with high math anxiety commonly experience low (or lower than expected) math performance due to some combination of these factors. Low math performance can hinder students from accessing higher education and/or lead to lack of access in certain disciplines [25–28]. While math anxiety can be related to a lack of foundational math skills [16], it is more likely that a combination of cognitive and emotional factors hinders high math-anxious students’ math performance.

Completing math tasks requires the use of our working memory, the cognitive stores and tools that hold information currently in conscious awareness [29]. Working memory is limited in space and time [29], and math is quite intensive on working memory resources [30]. A person with high math anxiety is likely to engage in negative self-talk and/or use strategies that use a lot of cognitive working memory resources [30,31]; therefore, a student with high math anxiety has fewer working memory resources with which to complete math tasks.

Another explanation for the lower performance in highly math-anxious students is the important role of self-efficacy in the relationship between math anxiety and math performance.

1.2. Self-Efficacy

Self-efficacy, or confidence in one’s ability to successfully complete a specific task, is considered a central factor in student learning [32,33]. Individuals with high self-efficacy to complete a task are more likely to successfully complete that task; however, there is not a causal link between the efficacy and performance [34–36]. Self-efficacy’s impact on academic performance is in part due to the relationship between self-efficacy and motivation [37,38], volition [39], effort and persistence [38,40,41], and goals [39]. As such, students with high self-efficacy in a specific area are likely to have positive attitudes about that area and engage in behaviors that are more likely to lead to success.

Self-efficacy is extremely specific, however, and individuals have varying levels of self-efficacy across different domains and tasks. Particularly important in mathematics and math anxiety is math self-efficacy. Math self-efficacy is one’s confidence in their ability to successfully complete a specific math task [42]. This type of self-efficacy is consistently negatively related to math anxiety and performance, meaning that students low in math self-efficacy often experience high math anxiety and low math performance [43–47]. Self-efficacy in mathematics has such a heavy impact on individuals that it often influences major decisions in their lives such as which college major to choose and which career path they take [48,49]. Because individuals with high math anxiety are less likely to have high math self-efficacy [43–47], other types of self-efficacy may play an important role.

Another type of self-efficacy that may mediate the emotional component of math anxiety is emotional self-efficacy, or an individual's perceived confidence in their ability to identify and regulate their emotions [44,47]. Individuals with low emotional self-efficacy often experience symptoms of depression and anxiety, whereas highly efficacious individuals are less likely to experience negative emotionality [44,50,51]. Emotional self-efficacy has been found to mediate the relationship between academic stress and suicidal risk [52] and to serve as a strong mediating factor in the negative relationship between elementary students' math anxiety and performance [44]. As such, it appears that individuals' confidence in their ability to identify and regulate their emotions plays a role between anxiety and outcomes. Because individuals with high emotional self-efficacy can mediate, on some level, the negative relationship between math anxiety and performance, perhaps emotional self-efficacy specific to math may be a stronger mediator of this relationship.

Emotional self-efficacy in math is (as it sounds) a combination of math self-efficacy and emotional self-efficacy. It is an individual's perceived ability to identify and control their emotions during math tasks. While this is extremely specific, confidence in one's emotional efficacy likely varies between contexts; as such, a highly math-anxious individual may be overall confident in their emotional regulation but not during math tasks due to the strong emotional nature of math anxiety. The specificity of this type of self-efficacy may be the reason it has not been examined in the existing literature. The lack of research in this area opens the possibility that emotional self-efficacy in math is an otherwise undiscovered mediator in the negative math anxiety–performance relationship.

1.3. The Current Study

Previous literature in math anxiety shows a clear role of math self-efficacy in the relationship between anxiety and performance. However, math anxiety has an emotional component; Galla and Wood [44] showed that children with higher confidence in their abilities to regulate their emotions (i.e., emotional self-efficacy) can control their emotions to decrease the effects of their anxiety on their performance. Palestro and Jameson [47] were not able to replicate this finding in adults. These contrary findings may be due to the specific nature of self-efficacy. In adults, emotional self-efficacy may be too broad to impact math specifically. As such, we decided to explore a more specific type of emotional self-efficacy—emotional self-efficacy specifically in math contexts. Based on this, the current research is guided by the following question:

RQ 1: Do emotional self-efficacy and/or emotional self-efficacy specifically in math mediate the relationship between math anxiety and math performance beyond the effect of math self-efficacy?

See Figure 1 for possible mediating effects that are being explored in the current study.

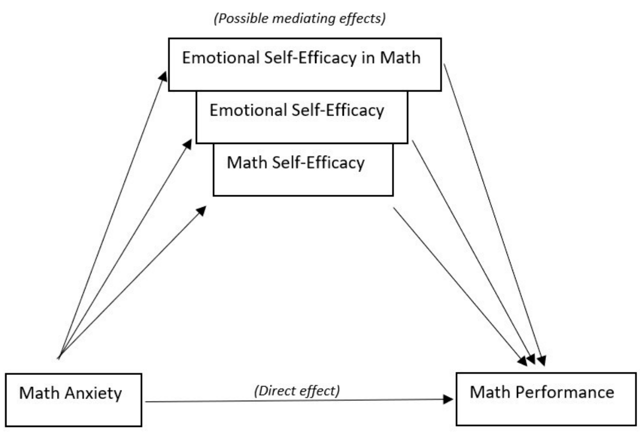

Figure 1. Study variables and possible mediating effects of relationships.

2. Materials and Methods

2.1. Participants

Participants of the study were 118 undergraduate students from a university in the Mountain West region of the United States who were enrolled in an introductory psychology course. A majority of the sample identified as female (n = 90; 76%), with 2% of the sample identifying as transgender (n = 2). The average age of participants was 19.87 years (range = 18–59), and most (56%) were in their first year at university. A total of 73% of participants self-identified as white (n = 86), 23% as Latinx/Hispanic (n = 27), 8% as Asian (n = 10), and 7% as Black (n = 8). Furthermore, 41% of the sample were first-generation college students (n = 48). All participants completed informed consent prior to their participation, and all received course credit in return for completing all measures.

2.2. Measures

The *Abbreviated Math Anxiety Scale* (AMAS) [53] was used to measure self-reported math anxiety. 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"). Scores are summed (range = 9–45), with higher scores indicating higher mathematics anxiety. Hopko et al. [45] report excellent internal consistency (Cronbach's α = 0.90) and test–retest reliability (r = 0.85 over a 2-week period) of the AMAS; validity has also been established through correlation with a longer math anxiety measure (r = 0.85).

The *Math Self-Efficacy Scale* (MSES) [42] was used to measure self-efficacy levels in math. This nine-item Likert-type scale (1 = not at all confident, 5 = very confident) prompts participants to estimate their confidence in their ability to complete specific math tasks in the classroom (e.g., "work with decimals" or to "determine the degrees of a missing angle"). Responses are summed (range = 9–45), with higher scores indicating higher levels of math self-efficacy. The MSES has both strong internal consistency reliability (Cronbach's α = 0.93) and validity through relationships with students' past math grades, scores on an established math self-concept measure, and students' expected math grades [34].

The *Emotional Self-Efficacy Scale* (ESES) [54], a 34-item Likert-type scale (1 = not at all confident and 5 = very confident), was used to measure self-efficacy in emotional awareness and regulation. This scale measures an individual's belief in their ability to control their emotions. Students are asked to rate their confidence level for their ability to engage in a variety of emotional tasks (e.g., "correctly identify when another person is feeling a positive emotion," and "notice the emotion your body language is portraying"). Scores are summed (range 34–170), with higher scores indicating a higher level of confidence in one's emotional self-efficacy. Kirk and colleagues [54] report excellent psychometric properties of the ESES.

To measure students' emotional self-efficacy specifically in math, the authors used the ESES and added "in math [courses, classes, tests . . .]" to each item. Two of the authors and two undergraduate research assistants reviewed the new scale and made edits for grammar and flow. The Emotional Self-Efficacy in Math Scale (ESEMS) was the product of this endeavor and has the same response and scoring options as the ESES. Though a new measure, reliability in the current sample was strong (see Table 1 for all internal consistency alpha coefficients).

The math computation subtest of the Wide Range Achievement Test 4 (WRAT4) [55] was used as the measure of math performance. The math computation subtest consists of both a written and oral section; only the written section was used in this research. As such, the WRAT4 standardized scores for math performance were not used, but raw scores on the 40-item math computation subtest were used. This paper-and-pencil math test is progressive in difficulty and is timed at 15 min. Previous research has successfully used the WRAT4 math computation in this way [47,56]. The WRAT4 is typically presented in person via a paper-and-pencil assessment. Due to the impact of the worldwide pandemic, we were unable to successfully collect face-to-face data; instead, we created an online version of the WRAT4 math computation subtest using Qualtrics software.

A comprehensive demographic questionnaire was used with a total of 10 items. These items asked participants to self-report their gender identity, student status, year in school, race/ethnic identity, and other relevant demographic information. Participants were given an option to not respond to any demographic questions, and all items included both "my identity is not represented . . . " with a text box and "do not want to answer . . . " option.

Table 1. Reliability and Descriptive Statistics for Study Measures.

	Internal Consistency α	Mean	SD	Range
Math anxiety (AMAS)	0.91	26.5	7.94	9–45
Math self-efficacy (MSES)	0.88	31	7.94	9–45
Emotional self-efficacy (ESES)	0.91	72.58	12.37	20–100
Emotional self-efficacy in math (ESEMS)	0.93	48.15	11.07	20–100
Math performance (WRAT4)	NA *	26.09	4.29	0–40

* Note: Internal consistency α was not computed for math performance, as the assessment progressively increases in difficulty.

2.3. Procedures

Participants signed up in an online system (Sona) and received a link to the Qualtrics survey. Upon acknowledging informed consent, students were given the AMAS, ESES, ESEMS, WRAT4, and demographics questionnaires in a counterbalanced order. Once submitted, participants received course credit for participation. It took students an average of 20 min to complete all the measures.

3. Results

3.1. Psychometric and Scale Descriptive Statistics

Prior to conducting inferential statistical analyses, we analyzed the internal consistency reliability of all scales, as well as the alpha if item-deleted analysis. As Table 1 shows, all scales used in this study showed strong internal consistency in the current sample. There were no increases in alpha with deleting items. As such, subsequent analyses can be considered robust. Table 1 also shows the descriptive information for each scale used with this sample.

3.2. Mediation Analysis

To determine the mediating effects of specific types of self-efficacy on the relationship between math anxiety and performance, a series of regression analyses was conducted. Assumptions of regression were checked, and all assumptions were met, including a linear relationship between the variables, independence of observations, normally distributed data, and evidence of homoscedasticity. Following Baron and Kenny [57,58], we followed a four-step approach to determining mediation. First, the direct effect of math anxiety on math performance was determined with a simple linear regression, which showed a clear, negative relationship between math anxiety and math performance, $R^2 = 0.149$, $b = -0.385$. Then, simple linear regressions were conducted with math anxiety predicting each potential mediating variable and showed significant relationships between math anxiety and math self-efficacy ($R^2 = 0.348$, $b = -0.594$) and emotional self-efficacy in math ($R^2 = 0.19$, $b = -0.44$) but not emotional self-efficacy overall ($R^2 = -0.006$, $b = -0.053$). Third, simple linear regressions were conducted with each potential mediator and math performance and showed a significant relationship with math self-efficacy ($R^2 = 0.202$, $b = 0.457$) but not emotional self-efficacy overall ($R^2 = 0.011$, $b = -0.139$) or emotional self-efficacy in math ($R^2 = 0.005$, $b = 0.116$).

Once these three steps were complete, a multiple hierarchical linear regression with MSE, ESE, and ESEM, entered in independent steps, was conducted to determine the mediating effect of each of these variables. Though ESE and ESEM were revealed as unlikely mediators in earlier steps, we determined that keeping these in the model could provide clarity (see MacKinnon et al., 2007), particularly given the novel and exploratory nature of this research. This regression showed that, as expected, MSE fully mediated the relationship between math anxiety and performance, R^2 = 0.229, b = 0.352 (see Block 2). Students with high anxiety but high MSE did not experience as big of a performance deficit as low MSE students. ESE partially mediates this relationship beyond MSE, R^2 = 0.278, b = −0.228 (see Block 3). Adding ESE (see Block 3) to the model explains an additional 3% of the variance in math anxiety/performance scores. Students with high anxiety and low ESE experience a performance deficit. However, this analysis showed that ESEM (see Block 4) does not have a mediating role in the relationship between anxiety and performance, R^2 = 0.281, b = −0.074. See Table 2 for full regression results.

Table 2. Hierarchical Regression Analysis Summary Table with Math Anxiety as Predictor Variable, Math Self-Efficacy, Emotional Self-Efficacy, and Emotional Self-Efficacy in Math as Mediator Variables, and Math Performance as Outcome Variable.

Variable	Standardized Beta Coefficient	t	p	Adjusted R^2
Block 1				0.149
Math anxiety	−0.385	−4.499	<0.001	
Block 2				0.229
Math anxiety	−0.176	−1.732	0.086	
Math self-efficacy [a]	0.352	3.453	0.001	
Block 3				0.259
Math anxiety	−0.154	−1.551	0.124	
Math self-efficacy [a]	0.410	4.052	<0.001	
Emotional self-efficacy [b]	−0.228	−2.795	0.006	
Block 4				0.255
Math anxiety	−0.174	−1.668	0.098	
Math self-efficacy [a]	0.429	4.06	<0.001	
Emotional self-efficacy [b]	−0.191	−1.924	0.057	
Emotional self-efficacy in math	−0.074	−0.644	0.521	

[a] Full mediator; [b] Partial mediator.

4. Discussion

The need to perform math calculations is a foundational life skill. Given this, math anxiety has the potential to negatively impact a person's academic and personal life [2,3]. For students, this negative relationship between math anxiety and performance can have profound implications such as limiting their access to certain courses or careers [18,19], which further influences the trajectory of their lives. As such, it is important to take into consideration other variables that may influence this relationship. Math self-efficacy, or one's belief in their ability to successfully complete math-related tasks, has shown to mediate the negative relationship between anxiety and performance [43–47]. Emotional self-efficacy, or one's belief in their ability to successfully identify and regulate their emotions, influences the relationship between anxiety and performance in children [44] but not college students [47]. Because self-efficacy is task-specific, we explored students' efficacy for their emotional identification and regulation specifically in math contexts.

Math self-efficacy, or confidence in one's ability to succeed at math tasks, remains the most relevant factor in math anxiety's impact on performance. Contrary to Palestro and Jameson [47], emotional self-efficacy was also a small yet relevant mediator in this study, suggesting the need for further work exploring specific types of self-efficacies in math anxiety. However, contrary to expectations, emotional efficacy specifically within math contexts did not play a role in this relationship. There are several possible explanations for this finding that are contrary to our hypothesis. This is the first known study to research emotional efficacy specifically within math, and as such, it is possible that there are some issues related to construct validity. Perhaps emotional self-efficacy is a construct that does not differentiate between specific contexts; alternatively, the newly developed measure used in the current work may not provide a strong assessment of the construct. Overall, the findings reveal that individuals with high math anxiety and high math and/or emotional self-efficacy are less likely to experience a performance deficit in our sample.

This research provides valuable information to scholars within education and behavioral sciences, as well as mathematics education. In addition to contributing to the scientific knowledge on math anxiety and self-efficacy, these findings provide important information for the development and implementation of interventions for math-anxious students. Our findings suggest that math self-efficacy remains the strongest mediator in the relationship between math anxiety and math performance, and as such, educational intervention efforts should emphasize enhancing students' math self-efficacy over other types of self-efficacy. Given the findings that emotional self-efficacy also mediates this relationship, additional work should continue exploring the role of emotional self-efficacy in the relationship between anxiety and performance to better understand the need for intervention and training in emotional self-efficacy.

5. Limitations and Future Directions

This study sample was limited to students enrolled in an undergraduate psychology course at a single university, which inhibits the generalizability of the results. Additional work should broaden the sample to include students in other courses (e.g., mathematics courses), other data collection sites, and additional student demographic characteristics (e.g., students in k-12, adult learners, and graduate students). This research was the first known to explore emotional self-efficacy specifically within math; as previously mentioned, the scale used to measure this construct should receive additional attention to determine the validity and utility of this specific type of efficacy.

Further research is needed to explore the mediating roles of various self-efficacies in the relationship between math anxiety and performance. Specifically, more research is warranted to clarify the role and function of emotional self-efficacy. In addition, the level of influence of specific efficacies needs to be explored given various levels of math anxiety. This is particularly true for assisting in the development and implementation of effective interventions that target the most salient variables in the relationship between anxiety and performance to improve student learning and performance.

Author Contributions: Conceptualization, M.M.J.; data curation, C.D. and J.Y.; formal analysis, M.M.J.; methodology, M.M.J.; project administration, M.M.J. and J.Y.; resources, J.Y.; supervision, M.M.J.; writing—original draft, M.M.J. and C.D.; writing—review and editing, C.D. and J.Y. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded in part by the University of Northern Colorado Graduate Student Association.

Institutional Review Board Statement: This study was conducted in accordance with ethical guidelines and after approval of the Institutional Review Board of the location (protocol 210202194, approved 2 December 2021).

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

Data Availability Statement: Data are available by contacting the corresponding author.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Gallup. Education. 2016. Available online: https://news.gallup.com/poll/1612/education.aspx (accessed on 1 March 2022).
2. Ashcraft, M.H. Math anxiety: Personal, educational, and cognitive consequences. *Curr. Dir. Psychol. Sci.* **2002**, *11*, 181–185. [CrossRef]
3. Richardson, F.C.; Suinn, R.M. The mathematics anxiety rating scale: Psychometric data. *J. Couns. Psychol.* **1972**, *19*, 551–554. [CrossRef]
4. Zakariya, Y.F.; Barattucci, M.; Fernández-Cézar, R.; Solano-Pinto, N. Analysis of relations between attitude towards mathematics, prior knowledge, self-efficacy, expected and actual grades in mathematics. In Proceedings of the Twelfth Congress of the European Society for Research in Mathematics Education (CERME12), Bolzano, Italy, 2–6 February 2022.
5. National Research Council. Adding it up: Helping children learn mathematics. In *Mathematics Learning Study Committee*; Kilpatrick, J., Swafford, J., Findell, B., Eds.; Center for Education, Division of Behavioral and Social Sciences and Education, National Academy Press: Washington, DC, USA, 2001.
6. Awofala, A.O.; Lawal, R.F.; Arigbabu, A.A.; Fatade, A.O. Mathematics productive disposition as a correlate of senior secondary school students' achievement in mathematics in Nigeria. *Int. J. Math. Educ. Sci. Technol.* **2022**, *53*, 1326–1342. [CrossRef]
7. Feldhaus, C.A. How pre-service elementary school teachers' mathematical dispositions are influenced by school mathematics. *Am. Int. J. Contemp. Res.* **2014**, *4*, 91–97.
8. Kusmaryono, I.; Suyitno, H.; Dwijanto, D.; Dwidayati, N. The effect of mathematical disposition on mathematical power formation: Review of dispositional mental functions. *Int. J. Instr.* **2019**, *12*, 343–356. [CrossRef]
9. Ma, X. Reciprocal relationships between attitude toward mathematics and achievement in mathematics. *J. Educ. Res.* **1997**, *90*, 221–229. [CrossRef]
10. Suárez-Pellicioni, M.; Núñez-Peña, M.I.; Colomé, À. Math anxiety: A review of its cognitive consequences, psychophysiological correlates, and brain bases. *Cogn. Affect. Behav. Neurosci.* **2016**, *16*, 3–22. [CrossRef]
11. Luttenberger, S.; Wimmer, S.; Paechter, M. Spotlight on math anxiety. *Psychol. Res. Behav. Manag.* **2018**, *11*, 311–322. [CrossRef]
12. Ganley, C.M.; McGraw, A.L. The development and validation of a revised version of the Math Anxiety Scale for Young Children. *Front. Psychol.* **2016**, *7*, 1181. [CrossRef]
13. Paechter, M.; Macher, D.; Martskvishvili, K.; Wimmer, S.; Papousek, I. Mathematics anxiety and statistics anxiety: Shared but also unshared components and antagonistic contributions to performance in statistics. *Front. Psychol.* **2017**, *8*, 1196. [CrossRef]
14. Blazer, C. Strategies for reducing math anxiety. *Inf. Capsul.* **2011**, *1102*, 1–8.
15. Lyons, I.M.; Beilock, S.L. When math hurts: Math anxiety predicts pain network activation in anticipation of doing math. *PLoS ONE* **2012**, *7*, e48076. [CrossRef] [PubMed]
16. Ashcraft, M.H.; Ridley, K.S. Math anxiety and its cognitive consequences—A tutorial review. In *Handbook of Mathematical Cognition*; Campbell, J.I.D., Ed.; Psychology Press: New York, NY, USA, 2005; pp. 315–327.
17. Moore, A.M.; McAuley, A.J.; Allred, G.A.; Ashcraft, M.H. Mathematics anxiety, working memory, and mathematical performance. In *The Routledge International Handbook of Dyscalculia and Mathematical Learning Difficulties*; Chinn, S., Ed.; Routledge: New York, NY, USA, 2014; pp. 326–336.
18. Ahmed, W. Developmental trajectories of math anxiety during adolescence: Associations with STEM career choice. *J. Adolesc.* **2018**, *67*, 158–166. [CrossRef] [PubMed]
19. Levy, H.E.; Fares, L.; Rubinsten, O. Math anxiety affects females' vocational interests. *J. Exp. Child Psychol.* **2021**, *210*, 105214. [CrossRef]
20. Xie, F.; Xin, Z.; Chen, X.; Zhang, L. Gender difference of Chinese high school students' math anxiety: The effects of self-esteem, test anxiety, and general anxiety. *Sex Roles* **2019**, *81*, 235–244. [CrossRef]
21. Akin, A.; Kurbanoglu, I.N. The relationships between math anxiety, math attitudes, and self-efficacy: A structural equation model. *Stud. Psychol.* **2011**, *53*, 263–273.
22. Hembree, R. The nature, effects, and relief of mathematics anxiety. *J. Res. Math. Educ.* **1990**, *21*, 33–46. [CrossRef]
23. Núñez-Peña, M.I.; Suárez-Pellicioni, M.; Bono, R. Effects of math anxiety on student success in higher education. *Int. J. Educ. Res.* **2013**, *58*, 36–43. [CrossRef]
24. Jameson, M.M.; Allen, M. How avoidant are math anxious people? Let me count the ways: Behavioral inhibition, harm avoidance, & experiential avoidance. In Proceedings of the Hawaii International Conference on Education, Waikoloa, HI, USA, 3 January 2022.
25. Green, A.; Sanderson, D. The roots of STEM achievement: An analysis of persistence and attainment in STEM majors. *Am. Econ.* **2018**, *63*, 79–93. [CrossRef]
26. Jameson, M.M.; Sexton, J.M. "Math Sucks!": The role of mathematics in undergraduate geoscience programs. In Proceedings of the University of Northern Colorado Annual Academic Excellence Week Conference, Greeley, CO, USA, 3 April 2017.
27. Jameson, M.M.; Sexton, J.M.; London, D.R.; Wenner, J.M. Math attitudes in undergraduate students enrolled in introductory geoscience courses. In Proceedings of the National Science Foundation AAAS-IUSE Summit, Washington, DC, USA, 1 June 2022.
28. Miranda, R.J.; Hermann, R.S.; Hurley, K.P.; Moore, J. Motivations for pursuing and challenges to completing geoscience majors at a public university. *J. Geosci. Educ.* **2021**, *69*, 300–312. [CrossRef]

29. Baddeley, A. Working memory. *Science* **1992**, *255*, 556–559. [CrossRef] [PubMed]
30. Ashcraft, M.H.; Krause, J.A. Working memory, math performance, and math anxiety. *Psychon. Bull. Rev.* **2007**, *14*, 243–248. [CrossRef] [PubMed]
31. Ramirez, G.; Gunderson, E.A.; Levine, S.C.; Beilock, S.L. Math anxiety, working memory, and math achievement in early elementary school. *J. Cogn. Dev.* **2013**, *14*, 187–202. [CrossRef]
32. Bandura, A. *Self-Efficacy: The Exercise of Control*; W.H. Freeman: New York, NY, USA, 1997.
33. Bernacki, M.L.; Nokes-Malach, T.J.; Aleven, V. Examining self-efficacy during learning: Variability and relations to behavior, performance, and learning. *Metacognition Learn.* **2015**, *10*, 99–117. [CrossRef]
34. Alhadabi, A.; Karpinski, A.C. Grit, self-efficacy, achievement orientation goals, and academic performance in university students. *Int. J. Adolesc. Youth* **2020**, *25*, 519–535. [CrossRef]
35. Lei, W.; Wang, X.; Dai, D.Y.; Guo, X.; Xiang, S.; Hu, W. Academic self-efficacy and academic performance among high school students: A moderated mediation model of academic buoyancy and social support. *Psychol. Sch.* **2022**, *59*, 885–899. [CrossRef]
36. Talsma, K.; Schüz, B.; Norris, K. Miscalibration of self-efficacy and academic performance: Self-efficacy ≠ self-fulfilling prophecy. *Learn. Individ. Differ.* **2019**, *69*, 182–195. [CrossRef]
37. Bandura, A.; Locke, E.A. Negative self-efficacy and goal effects revisited. *J. Appl. Psychol.* **2003**, *88*, 87–99. [CrossRef]
38. Zhen, R.; Liu, R.; Ding, Y.; Wang, J.; Liu, Y.; Xu, L. The mediating roles of academic self-efficacy and academic emotions in the relation between basic psychological needs satisfaction and learning engagement among Chinese adolescent students. *Learn. Individ. Differ.* **2017**, *54*, 210–216. [CrossRef]
39. Bandura, A.; Barbaranelli, C.; Caprara, G.V.; Pastorelli, C. Multifaceted impact of self-efficacy beliefs on academic functioning. *Child Dev.* **1996**, *67*, 1206–1222. [CrossRef]
40. Caraway, K.; Tucker, C.M.; Reinke, W.M.; Hall, C. Self-efficacy, goal orientation, and fear of failure as predictors of school engagement in high school students. *Psychol. Sch.* **2003**, *40*, 417–427. [CrossRef]
41. Wright, S.L.; Jenkins-Guarnieri, M.A.; Murdock, J.L. Career development among first-year college students: College self-efficacy, student persistence, and academic success. *J. Career Dev.* **2012**, *40*, 283–310. [CrossRef]
42. Nielsen, I.L.; Moore, K.A. Psychometric data on the mathematics self-efficacy scale. *Educ. Psychol. Meas.* **2003**, *63*, 128–138. [CrossRef]
43. Cooper, S.E.; Robinson, D.A. The relationship of mathematics self-efficacy beliefs to mathematics anxiety and performance. *Meas. Eval. Couns. Dev.* **1991**, *24*, 4–11.
44. Galla, B.M.; Wood, J.J. Emotional self-efficacy moderates anxiety-related impairments in math performance in elementary school-age youth. *Personal. Individ. Differ.* **2012**, *52*, 118–122. [CrossRef]
45. Meece, J.L.; Wigfield, A.; Eccles, J.S. Predictors of math anxiety and its influence on young adolescents' course enrollment intentions and performance in mathematics. *J. Educ. Psychol.* **1990**, *82*, 60–70. [CrossRef]
46. Jameson, M.M.; Fusco, B.R. Math anxiety, math self-concept, and math self-efficacy in adult learners compared to traditional undergraduate students. *Adult Educ. Q.* **2014**, *64*, 306–322. [CrossRef]
47. Palestro, J.J.; Jameson, M.M. Math self-efficacy, not emotional self-efficacy, mediates the math anxiety-performance relationship in undergraduate students. *Cogn. Brain Behav.* **2020**, *24*, 379–394. [CrossRef]
48. Hackett, G.; Betz, N.E. An exploration of the mathematics self-efficacy/ mathematics performance correspondence. *J. Res. Math. Educ.* **1989**, *20*, 261–273. [CrossRef]
49. Gabriel, M.H.; Atkins, D.; Chokshi, S.M.; Bowdon, M. Exploring math anxiety and math self-efficacy among health administration students. *J. Health Adm. Educ.* **2019**, *36*, 151–168.
50. Benfer, N.; Bardeen, J.R.; Clauss, K. Experimental manipulation of emotion regulation self-efficacy: Effects on emotion regulation ability, perceived effort in the service of regulation, and affective reactivity. *J. Context. Behav. Sci.* **2018**, *10*, 108–114. [CrossRef]
51. Muris, P. Relationships between self-efficacy and symptoms of anxiety disorders and depression in a normal adolescent sample. *Personal. Individ. Differ.* **2002**, *32*, 337–348. [CrossRef]
52. Ying, J.; You, J.; Guo, J. The protective effects of youth assets on the associations among academic stress, regulatory self-efficacy, and suicidal risk: A moderated mediation model. *Child. Youth Serv. Rev.* **2020**, *19*, 105660. [CrossRef]
53. Hopko, D.R.; Mahadevan, R.; Bare, R.L.; Hunt, M.K. The abbreviated math anxiety scale (AMAS) construction, validity, and reliability. *Assessment* **2003**, *10*, 178–182. [CrossRef]
54. Kirk, B.A.; Schutte, N.S.; Hine, D.W. Development and preliminary validation of an emotional self-efficacy scale. *Personal. Individ. Differ.* **2008**, *45*, 432–436. [CrossRef]
55. Wilkinson, G.S.; Robertson, G.J. *The Wide Range Achievement Test 4 (WRAT4)*; Pearson: New York, NY, USA, 2006.
56. Jameson, M.M. The development and validation of the Children's Anxiety in Math Scale. *J. Psychoeduc. Assess.* **2013**, *31*, 391–395. [CrossRef]
57. MacKinnon, D.P.; Fairchild, A.J.; Fritz, M.S. Mediation analysis. *Annu. Rev. Psychol.* **2007**, *58*, 593–614. [CrossRef]
58. Baron, R.M.; Kenny, D.A. The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical consideration. *J. Perosnality Soc. Psychol.* **1986**, *51*, 1173–1182. [CrossRef]