Instructional Technology and Lifelong Learning Vol. 6, Issue 1, 77-90 (2025)

https://dergipark.org.tr/en/pub/itall

ITALL

Research Article

ISSN: 2717-8307

Reducing Mathematics Anxiety: A Systematic Review

Emel TOPBAŞ TAT *[1], Ayşegül TOPBAŞ [2]

* *Corresponding etopbastat@erbakan.edu.tr*
[1]*Necmettin Erbakan University, Türkiye*
[2]*Ministry of National Education, Türkiye*

Abstract

The aim of this study is to examine the graduate theses that aimed to determine the effect of an instructional intervention on mathematics anxiety. For this purpose, graduate theses were reviewed and 22 theses were identified. Descriptive content analysis, which is one of the systematic review methods, was used in the study. Theses were examined according to their years, types, participant groups, instructional interventions used to eliminate or reduce mathematics anxiety, and the effects of the instructional interventions discussed. According to the results of the study, it was seen that most theses on this subject were prepared in 2016 and 2019. It has been determined that the majority of the theses are master thesis. In addition, it was concluded that the theses were carried out with 7th grade students at most. It was also found that the instructional interventions used to overcome mathematics anxiety were different in almost all of the theses examined. Considering the effects of the instructional interventions discussed, it is among the results that in the most of the theses, the instructional intervention did not have a significant effect on reducing mathematics anxiety.

Keywords: Mathematics anxiety, Instructional intervention, Graduate thesis

Citation: Topbaş Tat, E., & Topbaş, A. (2025). Reducing Mathematics Anxiety: A Systematic Review. *Instructional Technology and Lifelong Learning, 6(1)*, 77-90. https://doi.org/10.52911/itall.1563157

Matematik Kaygısının Azaltılması: Bir Sistematik Derleme

Özet

Bu çalışmanın amacı bir öğretimsel müdahalenin matematik kaygısı üzerindeki etkisini belirlemeyi amaçlayan lisansüstü tezleri incelemektir. Bu amaçla lisansüstü tezler taranmış ve 22 adet tez belirlenmiştir. Çalışmada sistematik derleme yöntemlerinden olan betimsel içerik analizi kullanılmıştır. Tezler, yıllarına, türlerine, katılımcı gruplarına, matematik kaygısını gidermek veya azaltmak için kullanılan öğretimsel müdahalelere, ele alınan öğretimsel müdahalelerin etkilerine göre incelenmiştir. Çalışma sonuçlarına göre bu konuda yapılan lisansüstü tezlerin en fazla 2016 ve 2019 yıllarında hazırlandığı görülmüştür. Lisansüstü tezlerin çoğunluğunun yüksek lisans tez çalışması olduğu belirlenmiştir. Ayrıca tezlerin en fazla 7. sınıf öğrencileriyle yürütüldüğü sonucuna ulaşılmıştır. İncelenen tezlerin neredeyse tamamında matematik kaygısının üstesinden gelmek için kullanılan öğretimsel müdahalelerin farklı olduğu da görülmüştür. Ele alınan öğretimsel müdahalelerin etkilerine bakıldığında ise tezlerin çoğunda, öğretimsel müdahalenin matematik kaygısını azaltmada anlamlı bir etkiye sahip olmadığı ulaşılan sonuçlar arasındadır.

Anahtar Kelimeler: Matematik kaygısı, Öğretimsel müdahale, lisansüstü tez

Date of Submission	07.10.2024
Date of Acceptance	24.11.2024
Date of Publication	30.06.2025
Peer-Review	Double anonymized - Two External
Ethical Statement	It is declared that scientific and ethical principles have been followed while carrying out and writing this study and that all the sources used have been properly cited.
Acknowledgements	
Author(s) Contribution	**Author1:** Conceptualization, Methodology, Writing- Original draft preparation, Writing- Reviewing and Editing **Author2:** Data curation, Writing- Original draft preparation, Writing- Reviewing and Editing
Plagiarism Checks	Yes - Turnitin
Conflicts of Interest	The author(s) has no conflict of interest to declare.
Complaints	Itall.journal@gmail.com
Grant Support	The author(s) acknowledge that they received no external funding in support of this research.
Copyright & License	Authors publishing with the journal retain the copyright to their work licensed under the **CC BY 4.0**.

1. Introduction

Mathematics anxiety is a common condition that many people encounter in their experiences with mathematics. Mathematics anxiety can be defined as "feelings of tension and worry that interfere with the manipulation of numbers and the solution of mathematical problems in a wide variety of ordinary life and academic situations" (Richardson & Suinn, 1972, p. 551). The causes of mathematics anxiety include negative life experiences related to learning mathematics, environmental factors, gender role, genetic factors and neurocognitive effects, social factors, and dyscalculia (Kurnaz et al., 2021). Mathematics anxiety can negatively affect students' experiences with mathematics and prevent them from establishing a positive relationship with mathematics. As the level of anxiety increases, students may avoid mathematics-related activities, studying or completing homework assignments, and may experience fear of failing exams (Alkan, 2010). Mathematics anxiety can negatively affect students' learning in mathematics and prevent them from reaching their full academic potential (Finell et al., 2022; Gabriel et al., 2020). Considering that the principles and techniques of mathematics have become a part of almost all fields of study, it can be said that mathematics anxiety can also result in low performance in these fields of study (Tobias, 1990).

Mathematics anxiety can negatively affect mathematics performance and have a negative impact on cognitive functioning (Ashcraft & Kirk; 2001; Morsanyi et al., 2014). Many studies agree that mathematics anxiety negatively affects mathematics achievement (e.g., Hembree, 1990; Ma, 1999; Wang, 2020). In addition, it is worth noting that the relationship between mathematics anxiety and mathematics performance is bidirectional. Low performance can lead to mathematics anxiety, and mathematics anxiety can reduce mathematics performance. Therefore, it is thought that mathematics anxiety and mathematics performance may affect each other in a vicious circle (Carey et al., 2016).

Coping with mathematics anxiety is important in terms of improving mathematics skills and reducing the negative emotional relationship with mathematics. Effective methods and practices used in classrooms to reduce mathematics anxiety can help students cope with their mathematics anxiety and have a more positive experience of mathematics. This, in turn, can improve students' mathematics performance and self-confidence (Codding et al., 2023). In the literature, various interventions such as relaxation training, breathing exercises, expressive

writing activities, class discussions, cooperative learning and reciprocal learning are discussed to prevent or reduce mathematics anxiety (Dilmaç & Bakır, 2022).

The systematic study of mathematics anxiety began in the 1950s with pioneering work of Dreger and Aiken (1957), who introduced the term "number anxiety". The Mathematics Anxiety Rating Scale (MARS) developed by Richardson and Suinn (1972) was a significant milestone in research methodology. There are several types of studies in the mathematics anxiety literature. Some of these are definitional and measurement studies, which include studies that define what mathematics anxiety is and develop tools to measure it (Bindak, 2005; Hunt et al., 2011; Plake & Parker, 1982; Richardson & Suinn, 1972). Some studies investigate the possible causes of mathematics anxiety (Alkan, 2011; Beilock et al., 2010; Maloney et al., 2015; Ramirez et al., 2013), while others focus on the effects of mathematics anxiety in various areas (Ashcraft & Krause, 2007; Beilock & Maloney, 2015). There are also intervention studies investigating strategies to reduce mathematics anxiety (Park et al., 2014; Ramirez & Beilock, 2011; Supekar et al., 2015). Systematic review of the studies on mathematics anxiety plays a crucial role in deepening our understanding of mathematics anxiety and improving educational practices. However, many existing systematic reviews primarily concentrate on its association with mathematics achievement, placing less emphasis on strategies for intervening mathematics anxiety within educational settings (Codding et al., 2023). The strategies aimed at addressing mathematics anxiety hold significant importance owing to their extensive implications on educational outcomes, psychological wellness, and professional opportunities (Zhu et al., 2024). In this direction, the aim of the study was to examine the graduate theses conducted in Türkiye that aimed to determine the effect of an instructional intervention on mathematics anxiety. The sub-problems of the study were determined as follows:

1. What is the distribution of theses by year?
2. What is the distribution of theses by type?
3. What is the distribution of theses by participant group?
4. What are the instructional interventions used in the theses to reduce mathematics anxiety?
5. What are the effects of the instructional interventions used in the theses on reducing mathematics anxiety?

It is believed that the results of this study will provide guidance for future studies by identifying the instructional interventions used in graduate theses to reduce mathematics anxiety and the effects of these interventions.

2. Method

This study used descriptive content analysis, one of the systematic review methods. Studies based on descriptive content analysis provide a summary of the current state of affairs on a particular topic and offers insights for future research to address the shortcomings in the field (Gough et al., 2011, as cited in Bellibaş, 2018). In this study, the aim was to examine the graduate theses that aimed to determine the effect of an instructional intervention implemented in mathematics lessons on mathematics anxiety. The descriptive content analysis method was used because the aim was to determine the current status of these issues by examining the theses according to year, type, participant group, the instructional intervention applied in mathematics lessons to reduce mathematics anxiety, and the effect of the instructional intervention.

2.1. Data Collection

This study examined graduate theses conducted in Türkiye that aimed to determine the effect of an instructional intervention on mathematics anxiety. In the YÖKTEZ database, graduate theses examining the effect of instructional interventions applied in mathematics lessons on mathematics anxiety were searched. The keyword "mathematics anxiety" was used for the search. The theses were searched without any year limitation and the search was carried out in June 2023. The theses were analyzed, and those involving instructional interventions were identified. The theses to be included in the study were limited by the fact that the instructional intervention was applied in mathematics lessons and that the full text was accessible. In this context, 22 theses prepared between 2008 and 2023 were identified.

2.2. Data Analysis

The theses were examined according to their years, types, participant groups, the instructional interventions used to reduce mathematics anxiety, and the effects of the instructional interventions used. The theses were first coded under these headings and then the findings were transformed into frequency tables. During the data analysis process, the authors first

analyzed the data independently and then worked together on the results obtained. The data analysis was finalized by reaching common decisions and conclusions.

3. Result

The first sub-problem of the study is "What is the distribution of theses by years?". The distribution of theses that aimed to determine the effect of an instructional intervention applied in mathematics lessons on mathematics anxiety by year is shown in Table 1.

Table 1.

Distribution of Theses by Year

Year	f	%	Year	f	%
2008	2	9.09	2018	3	13.64
2011	1	4.55	2019	4	18.18
2013	1	4.55	2020	1	4.55
2015	1	4.55	2022	3	13.64
2016	4	18.18	2023	1	4.55
2017	1	4.55	Total	22	100

Table 1 shows that most of the graduate theses aiming to determine the effect of an instructional intervention applied in mathematics lessons on mathematics anxiety were prepared in 2016 and 2019 (f=4, 18.18%). These years were followed by 2018 and 2022 with 3 theses (f=3, 13.64%). The years with one thesis (f=1, 4.55%) are 2011, 2013, 2015, 2017, 2020 and 2023. Before 2008 and in 2009, 2010, 2012, 2014 and 2021, no thesis was found on this subject.

The second sub-problem of the study is "What is the distribution of theses by type?". The distribution of theses by type is shown in Table 2.

Table 2.

Distribution of Theses by Type

Type	f	%
Master Thesis	18	81.82
Doctoral Thesis	4	18.18
Total	22	100

Table 2 shows that most of the graduate theses (f=18, 81.82%) were written as master theses. Four doctoral theses (18.18%) were also found on this subject.

The third sub-problem of the study is "What is the distribution of theses by participant group?". The distribution of theses by participant group is shown in Table 3.

Table 3.

Distribution of Theses by Participant Group

Participant Group	f	%	Participant Group	f	%
3rd grade students	1	4.55	8th Grade Students	2	9.09
4th grade students	5	22.73	9th Grade Students	2	9.09
5th grade students	1	4.55	10th Grade Students	1	4.55
6th Grade Students	3	13.64	Undergraduate students	1	4.55
7th Grade Students	8	36.36			

According to Table 3, the most frequently studied participant group in theses aiming to determine the effect of an instructional intervention on reducing mathematics anxiety were 7th grade students (f=8, 36.36%). Five theses were conducted with 4th grade students (22.73%). Three theses were conducted with 6th grade students, while the least frequently studied participant groups were 3rd, 5th and 10th grade students and undergraduate students (f=1, 4.55%). In addition, no theses were found that were conducted with 1st, 2nd, 11th and 12th grade students.

The fourth sub-problem of the study is "What are the instructional interventions used in the theses to reduce mathematics anxiety?". The instructional interventions used in the theses to reduce mathematics anxiety is shown in Table 4.

Table 4.

Distribution of Theses by Instructional Intervention

Instructional Intervention	f
Computer-Assisted Instruction with GeoGebra	2
STEM-Based Education	2
Writing Activities	2
Cognitive Reappraisal Interventions	1
CD Supported Materials	1
Multimedia Applications	1
Teaching Activities Prepared According to the Theory of Multiple Intelligences	1
Teaching with Activities	1
Realistic Mathematics Education Supported Instruction	1
Flipped Classroom Model Practice Focused on Blended Learning	1
Concept Cartoons	1
Team-Assisted Individualization Technique	1
Mathematical Modeling	1
Gamification-Based Activities	1
Instructional Material Use	1
Scenario Based Learning Method of the Historical Developments of the Mathematics Subjects	1
Activities Adapted by Using TESS-INDIA Open Education Resources	1
Web Assisted Instruction	1
Creative Drama	1
Enriched Education Program	1

Table 4 shows that the effects of 20 different instructional interventions on mathematics anxiety were investigated in 22 theses. A single instructional intervention was used in each of the 21 theses, while the effects of two different instructional interventions were analyzed separately in one thesis. There were two theses each investigating the effects of computer-assisted instruction with GeoGebra, STEM-based education and writing activities on mathematics anxiety. The other instructional interventions listed in the Table 4 were used in one thesis each.

The fifth sub-problem of the study is "What are the effects of the instructional interventions used in the theses on reducing mathematics anxiety?". The distribution of the theses according to the effects of the instructional interventions is shown in Table 5.

Table 5.

Distribution of Theses by the Effect of Instructional Intervention

Effect on Reducing Anxiety	f	%
A significant effect	9	40.91
No significant effect	14	63.64

According to Table 5, in the majority of the theses (f=14, 63.64%), the instructional intervention did not have a significant effect on reducing mathematics anxiety. However, 40.91% of the theses found a significant effect of the intervention on reducing mathematics anxiety.

According to the results, both theses investigating the effect of computer-assisted instruction with GeoGebra on students' mathematics anxiety found the same conclusion and concluded that the applied instructional intervention had no significant effect on reducing students' mathematics anxiety. The results also showed that some of the other instructional interventions examined in the theses had no significant effect on reducing students' mathematics anxiety. These interventions included: (a) cognitive reappraisal interventions, (b) CD supported materials, (c) multimedia applications, (d) teaching activities prepared according to the theory of multiple intelligences, (e) teaching with activities, (f) concept cartoons, (g) team-assisted individualization technique, (h) gamification-based activities, (i) scenario based learning method of the historical developments of the mathematics subjects and (j) activities adapted by using TESS-INDIA open education resources. However, it was found that two theses on STEM-based education reached different results. While one thesis found a significant effect of STEM-based education on reducing mathematics anxiety, the other found no significant effect on reducing mathematics anxiety. Similarly, it was found that two theses that used writing

activities produced different results in terms of their effect on reducing mathematics anxiety. While one thesis found a significant effect of writing activities on reducing mathematics anxiety, the other found no significant effect on reducing mathematics anxiety. Furthermore, the findings also revealed that various instructional interventions examined in the theses showed significant effects on reducing students' mathematics anxiety. These interventions included: (a) realistic mathematics education supported instruction, (b) flipped classroom model practice focused on blended learning, (c) mathematical modeling, (d) instructional material use, (e) web assisted instruction, (f) creative drama and (g) enriched education program.

4. Discussion and Conclusion

In this study, the graduate theses conducted in Türkiye that aimed to determine the effect of an instructional intervention on reducing mathematics anxiety were examined. The analyzed theses were accessed by searching the YÖKTEZ database. As a result of the search data, 22 graduate theses were found.

As a result of the data analysis, it was found that the theses examining the effect of an instructional intervention on reducing mathematics anxiety were prepared between 2008 and 2023. In some years (years before 2008 and years 2009, 2010, 2012, 2014 and 2021), no theses on this subject were found. Considering that mathematics anxiety is common condition that many people encounter in their experiences with mathematics and affects performance in mathematics, it is important to increase the number of theses on this subject.

When the theses were examined according to type, it was found that the majority were master theses. It was seen that there were few doctoral theses on the subject. This finding suggests the need for more in-depth research at doctoral level in this area, which could contribute to a more comprehensive theoretical framework and practical applications in this area.

When the participant groups of the theses were examined, it was found that 7th grade students were the most common participant group in the theses. In terms of participant groups, 7th grade students were followed by 4th grade students. In addition, no theses were found that were conducted with 1st, 2nd, 11th and 12th grade students. According to the results of the study, one thesis was found in which the participant group was undergraduate students. In this thesis, it was found that, despite the instructional intervention applied, no significant

change in students' mathematics anxiety level was observed. In later education, avoiding mathematics is connected to previous experiences of high levels of mathematics anxiety and low mathematics achievement during the early stages of learning (Espino et al., 2017). Investigating strategies to address mathematics anxiety from an early age has become a crucial area of research due to significant number of adolescent experiencing symptoms of mathematics anxiety (Luttenberger et al., 2018). In this regard, it is thought that it is necessary and important to conduct studies at all grade levels regarding instructional interventions to reduce mathematics anxiety.

In the 22 theses examined, it was seen that the effects of 20 different instructional interventions on reducing mathematics anxiety were investigated. The effects of only three of these interventions were investigated in more than one thesis. Both theses that investigated the effect of computer-assisted instruction with GeoGebra on students' mathematics anxiety found the same conclusion and concluded that the applied instructional intervention had no significant effect on reducing students' mathematics anxiety. On the other hand, it was found that two theses on STEM-based education reached different results. While one thesis found a significant effect of STEM-based education on reducing mathematics anxiety, the other found no significant effect on reducing mathematics anxiety. Similar results were found in two theses that used writing activities. While one thesis found a significant effect of writing activities on reducing mathematics anxiety, the other found no significant effect on reducing mathematics anxiety. The different results observed across similar interventions may highlight the complex nature of reducing mathematics anxiety. While computer-assisted instruction with GeoGebra consistently showed no significant effect, the varying outcomes in STEM-based education and writing activities suggest that the effectiveness of these interventions may be strongly influenced by implementation factors, contextual variables, and specific student populations rather than the intervention method alone. These findings emphasize the need for more detailed reporting of implementation processes and contextual factors in future research to better understand why similar interventions might produce different results. Additionally, this variation highlights the importance of considering multiple factors beyond the intervention type itself when attempting to reduce mathematics anxiety.

According to the results, 40.91% of the theses reported a significant effect of the intervention on reducing mathematics anxiety. However, it was found that the instructional interventions used

in the majority of the theses did not have a significant effect on reducing mathematics anxiety. Similarly, Dowker et al. (2016) reviewed various intervention types including cognitive-behavioral therapy, mindfulness, and classroom-based approaches and found that while some interventions were effective, others showed limited or no significant impact. So, it can be said that addressing math anxiety is a complex process and there is a need for more rigorous research designs (Dowker et al., 2016). So, it can be recommended that future interventions focus not only on the method chosen, but also on ensuring proper implementation conditions, adequate duration, and appropriate support structures. This analysis can provide a starting point for further research. To gain a more comprehensive understanding, the specific methodologies used in the theses, the characteristics of the study participants, and the broader context of mathematics education in which these interventions were implemented can be examined in detail.

5. References

Alkan, V. (2010). Matematikten nefret ediyorum! *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi, 28*(2), 189–199.

Alkan, V. (2011). Etkili matematik öğretiminin gerçekleştirilmesindeki engellerden biri: Kaygı ve nedenleri. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi, 29*(1), 89–107.

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. https://doi.org/10.1037/0096-3445.130.2.224

Ashcraft, M. H., & Krause, J. A. (2007). Working memory, math performance, and math anxiety. *Psychonomic Bulletin & Review, 14*(2), 243–248. https://doi.org/10.3758/BF03194059

Beilock, S. L., Gunderson, E. A., Ramirez, G., & Levine, S. C. (2010). Female teachers' math anxiety affects girls' math achievement. *Proceedings of the National Academy of Sciences, 107*(5), 1860–1863. https://doi.org/10.1073/pnas.0910967107

Beilock, S. L., & Maloney, E. A. (2015). Math anxiety: A factor in math achievement not to be ignored. *Policy Insights from the Behavioral and Brain Sciences, 2*(1), 4–12. https://doi.org/10.1177/2372732215601438

Bellibaş, M. Ş. (2018). Sistematik derleme çalışmalarında betimsel içerik analizi. In K. Beycioğlu, N. Özer, & Y. Kondakçı (Eds.), *Eğitim yönetiminde araştırma* (pp. 505–509). Pegem Akademi.

Bindak, R. (2005). İlköğretim öğrencileri için matematik kaygı ölçeği. *Fırat Üniversitesi Fen ve Mühendislik Bilimleri Dergisi, 17*(2), 442–448.

Carey, E., Hill, F., Devine, A., & Szücs, D. (2016). The chicken or the egg? The direction of the relationship between mathematics anxiety and mathematics performance. *Frontiers in Psychology, 6*, Article 1987. https://doi.org/10.3389/fpsyg.2015.01987

Codding, R. S., Goodridge, A. E., Hill, E., Kromminga, K. R., Chehayeb, R., Volpe, R. J., & Scheman, N. (2023). Meta-analysis of skill-based and therapeutic interventions to address math anxiety. *Journal of School Psychology, 100*, Article 101229. https://doi.org/10.1016/j.jsp.2023.101229

Dilmaç, B., & Bakır, V. (2022). Matematik kaygısını azaltmaya yönelik etkinlikler. In E. Ertekin & B. Dilmaç (Eds.), *Matematik kaygısı* (pp. 201–231). Pegem Akademi.

Dowker, A., Sarkar, A., & Looi, C. Y. (2016). Mathematics anxiety: What have we learned in 60 years? *Frontiers in Psychology, 7*, Article 508. https://doi.org/10.3389/fpsyg.2016.00508

Dreger, R. M., & Aiken, L. R. (1957). The identification of number anxiety in a college population. *Journal of Educational Psychology, 48*(6), 344–351. https://doi.org/10.1037/h0045894

Espino, M., Pereda, J., Recon, J., Perculeza, E., & Umali, C. (2017). Mathematics anxiety and its impact on the course and career choice of grade 11 students. *International Journal of Education, Psychology and Counselling, 2*(5), 99–119.

Finell, J., Sammallahti, E., Korhonen, J., Eklöf, H., & Jonsson, B. (2022). Working memory and its mediating role on the relationship of math anxiety and math performance: A meta-

analysis. *Frontiers in Psychology, 12*, Article 798090. https://doi.org/10.3389/fpsyg.2021.798090

Gabriel, F., Buckley, S., & Barthakur, A. (2020). The impact of mathematics anxiety on self-regulated learning and mathematical literacy. *Australian Journal of Education, 64*(3), 227–242. https://doi.org/10.1177/0004944120947881

Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. *Journal for Research in Mathematics Education, 21*(1), 33–46. https://doi.org/10.2307/749455

Hunt, T. E., Clark-Carter, D., & Sheffield, D. (2011). The development and part validation of a U.K. scale for mathematics anxiety. *Journal of Psychoeducational Assessment, 29*(5), 455–466. https://doi.org/10.1177/0734282910392892

Kurnaz, M. F., Dilmaç, B., & Ertekin, E. (2021). Matematik kaygısı. In E. Ertekin & B. Dilmaç (Eds.), *Matematiğin duyuşsal özellikleri* (pp. 85–105). Pegem Akademi.

Luttenberger, S., Wimmer, S., & Paechter, M. (2018). Spotlight on math anxiety. *Psychology Research and Behavior Management, 11*, 311–322. https://doi.org/10.2147/PRBM.S141421

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), 520–540. https://doi.org/10.2307/749772

Maloney, E. A., Ramirez, G., Gunderson, E. A., Levine, S. C., & Beilock, S. L. (2015). Intergenerational effects of parents' math anxiety on children's math achievement and anxiety. *Psychological Science, 26*(9), 1480–1488. https://doi.org/10.1177/0956797615592630

Morsanyi, K., Busdraghi, C., & Primi, C. (2014). Mathematical anxiety is linked to reduced cognitive reflection: A potential road from discomfort in the mathematics classroom to susceptibility to biases. *Behavioral and Brain Functions, 10*, Article 31. https://doi.org/10.1186/1744-9081-10-31

Park, D., Ramirez, G., & Beilock, S. L. (2014). The role of expressive writing in math anxiety. *Journal of Experimental Psychology: Applied, 20*(2), 103–111. https://doi.org/10.1037/xap0000013

Plake, B. S., & Parker, C. S. (1982). The development and validation of a revised version of the Mathematics Anxiety Rating Scale. *Educational and Psychological Measurement, 42*(2), 551–557. https://doi.org/10.1177/001316448204200218

Ramirez, G., & Beilock, S. L. (2011). Writing about testing worries boosts exam performance in the classroom. *Science, 331*(6014), 211–213. https://doi.org/10.1126/science.1199427

Ramirez, G., Gunderson, E. A., Levine, S. C., & Beilock, S. L. (2013). Math anxiety, working memory, and math achievement in early elementary school. *Journal of Cognition and Development, 14*(2), 187–202. https://doi.org/10.1080/15248372.2012.664593

Richardson, F. C., & Suinn, R. M. (1972). The Mathematics Anxiety Rating Scale: Psychometric data. *Journal of Counseling Psychology, 19*(6), 551–554. https://doi.org/10.1037/h0033456

Supekar, K., Iuculano, T., Chen, L., & Menon, V. (2015). Remediation of childhood math anxiety and associated neural circuits through cognitive tutoring. *Journal of Neuroscience, 35*(36), 12574–12583. https://doi.org/10.1523/JNEUROSCI.0786-15.2015

Tobias, S. (1990). Math anxiety: An update. *NACADA Journal, 10*(1), 47–50. https://doi.org/10.12930/0271-9517-10.1.47

Wang, L. (2020). Mediation relationships among gender, spatial ability, math anxiety, and math achievement. *Educational Psychology Review, 32*(1), 1–15. https://doi.org/10.1007/s10648-019-09487-z

Zhu, Y., Liu, X., Xiao, Y., & Sindakis, S. (2024). Mathematics anxiety and problem-solving proficiency among high school students: Unraveling the complex interplay in the knowledge economy. *Journal of Knowledge Economy, 15*(2), 6903–6922. https://doi.org/10.1007/s13132-023-01688-w