Open Access Research Journal of
Science and Technology
Journals home page: https://oarjst.com/
ISSN: 2782-9960 (Online)

(REVIEW ARTICLE)

Mathematical Resilience Framework (MRF): A new approach to overcoming math anxiety

Adenike Omonijo Toromade [1,*], Christiana Uchechukwu Orakwe [2] and Chioma Angela Okonkwo [3]

[1] *Air Force School VI, Lagos, Nigeria.*
[2] *Tuteria, Lagos, Nigeria.*
[3] *Community Secondary School, Umunnachi, Nigeria.*

Open Access Research Journal of Science and Technology, 2024, 12(02), 001–009

Publication history: Received on 18 September 2024; revised on 26 October 2024; accepted on 28 October 2024

Article DOI: https://doi.org/10.53022/oarjst.2024.12.2.0128

Abstract

Math anxiety is a significant barrier to student success in mathematics, often resulting in poor performance and disengagement from the subject. This paper introduces the Mathematical Resilience Framework (MRF), a novel approach that integrates cognitive-behavioral techniques with self-efficacy models to help students overcome math anxiety. The MRF emphasizes emotional regulation, mindset transformation, and confidence-building as key components in fostering resilience. This paper explores the theoretical foundation of mathematical resilience, the structure of the MRF, and its potential benefits when applied in educational settings. By comparing MRF to other interventions, it highlights how the framework addresses both the emotional and cognitive aspects of math anxiety. The paper concludes with recommendations for educators, policymakers, and researchers on integrating the MRF into educational systems to improve learning outcomes and support student success in mathematics.

Keywords: Mathematical resilience; Math anxiety; Cognitive-behavioral techniques; Self-efficacy; Emotional regulation

1. Introduction

1.1. Prevalence and Impact of Math Anxiety

Mathematics anxiety is a widespread issue affecting students at various educational levels across the globe. It is commonly defined as a feeling of tension, apprehension, or fear that interferes with math performance, leading to avoidance and, in many cases, significant struggles in academic achievement (Luttenberger, Wimmer, & Paechter, 2018). This phenomenon is not restricted to a small subset of individuals; it has been documented in students of all ages, from primary school to higher education. Studies have shown that as many as 20-30% of students may experience some form of math anxiety, with certain demographics, such as females and individuals from disadvantaged backgrounds, showing higher vulnerability (Derling, Magda, Gabriela, & Carmen, 2021). Math anxiety, therefore, constitutes a personal challenge for many learners and a widespread educational concern that affects learning outcomes on a larger scale (Mammarella, Caviola, & Dowker, 2019).

The prevalence of math anxiety has been extensively studied, with research consistently showing that a significant percentage of students suffer from this condition. The National Mathematics Advisory Panel in the U.S. has reported that math anxiety affects up to one-third of students in certain age groups (Palmer, 2023). The problem begins as early as elementary school and can persist into adulthood, negatively impacting both academic and professional trajectories. Studies suggest that the origins of math anxiety often stem from a combination of factors, including negative past experiences with mathematics, societal attitudes towards math as a difficult subject, and even the teaching methods employed by educators, which may inadvertently foster fear rather than understanding.

* Corresponding author: Adenike Omonijo Toromade

The negative impact of math anxiety on learning outcomes cannot be overstated. Math-anxious students typically avoid engaging with math-related subjects and tasks, leading to poor performance. This avoidance creates a vicious cycle in which the lack of practice reinforces the anxiety, and the anxiety further limits opportunities for learning and improvement. Research by Živković, Pellizzoni, Mammarella, and Passolunghi (2023) has highlighted how math anxiety significantly impairs working memory, a critical cognitive resource necessary for problem-solving and logical reasoning. When students are anxious about math, their cognitive resources are diverted towards managing their anxiety, leaving less capacity for processing mathematical information. As a result, their performance suffers, creating a cycle of poor achievement and increased anxiety. This has long-term consequences, including limited career opportunities in STEM (Science, Technology, Engineering, and Mathematics) fields, where mathematics is essential.

1.2. Introducing the Mathematical Resilience Framework (MRF)

In response to the growing concerns around math anxiety, educational researchers and psychologists have begun exploring strategies to help students build resilience in the face of mathematical challenges. The Mathematical Resilience Framework (MRF) is one such approach. It seeks to combine cognitive-behavioral techniques with models of self-efficacy to empower students to overcome math anxiety and enhance their learning outcomes.

Mathematical resilience, a concept adapted from the broader psychological understanding of resilience, refers to the ability to persevere in the face of mathematical difficulties. It involves developing a positive attitude towards math, a willingness to engage with challenging problems, and the belief that effort and practice can lead to improvement. The MRF builds on this concept by integrating established cognitive-behavioral techniques to address anxiety and emotional regulation with self-efficacy models that emphasize students' belief in their ability to succeed in specific tasks.

The rationale behind developing MRF is based on a need for interventions that do not merely address the symptoms of math anxiety but also foster a long-term, positive relationship with mathematics. While existing strategies often focus on quick fixes—such as test-taking strategies or relaxation techniques—the MRF aims for a more comprehensive solution that addresses both the cognitive and emotional aspects of math anxiety. The framework emphasizes helping students recognize that struggle and difficulty in mathematics are normal parts of the learning process, not indicators of failure or a lack of ability. By promoting this mindset, the MRF encourages students to approach math with greater confidence and persistence, reducing the likelihood of anxiety-driven avoidance (Tomasetto, Morsanyi, Guardabassi, & O'Connor, 2021).

1.3. Objective and Approach of the Paper

This paper aims to introduce and explore the Mathematical Resilience Framework as a novel approach to mitigating math anxiety. Unlike traditional interventions, which often focus on short-term coping mechanisms, the MRF aims to equip students with the tools they need to develop a resilient attitude towards mathematics. By fostering a combination of emotional regulation, self-efficacy, and problem-solving persistence, the framework seeks to empower students to overcome anxiety and improve their performance in math.

The paper will begin by providing an in-depth look at the concept of mathematical resilience, drawing on research from educational psychology to explain why resilience is a crucial factor in overcoming math anxiety. It will then proceed to discuss the key components of the MRF, specifically focusing on how cognitive-behavioral techniques and self-efficacy models are integrated into the framework. Next, the application and implications of the MRF will be explored, highlighting how educators and institutions can use this framework to enhance students' learning experiences and outcomes. Finally, the paper will conclude with recommendations for future research and practical suggestions for implementing MRF in diverse educational settings.

2. Understanding Mathematical Resilience

2.1. Mathematical Resilience as a Concept

Mathematical resilience is rooted in the understanding that struggle in learning mathematics is both natural and necessary. Traditional approaches to math education often emphasize speed, accuracy, and the ability to solve problems quickly. This creates an implicit message that struggling with a problem is a sign of weakness or failure, which leads to heightened anxiety and, in many cases, avoidance of the subject. Mathematical resilience challenges this mindset by teaching students to embrace difficulties as part of learning (Johnston-Wilder & Moreton, 2018).

The concept encourages students to adopt a growth mindset, a term popularized by psychologist Carol Dweck, which asserts that abilities can be developed through dedication and hard work. In mathematics, a growth mindset is crucial

for building resilience. Students who believe their abilities can grow through effort are more likely to tackle challenging problems with perseverance rather than giving up in frustration (Lee, 2021). Mathematical resilience also involves emotional regulation, as students need to manage feelings of stress and anxiety when they encounter difficult tasks. This emotional regulation and persistence form the foundation of resilience in mathematical learning (Boaler, 2022).

Several educational and psychological theories contribute to the development of mathematical resilience. First, the broader concept of resilience in education plays a foundational role. Educational resilience refers to students' ability to succeed in academic tasks despite personal difficulties, learning disabilities, or external pressures. In mathematics, resilience helps students persist in problem-solving, even when they experience failure or frustration. This ability to bounce back from setbacks is vital in subjects like mathematics, where errors and difficulties are common and where immediate success is not always guaranteed (Ross, Scanes, Poronnik, Coates, & Locke, 2022).

Self-efficacy, another key psychological concept, is closely tied to the development of mathematical resilience. Self-efficacy, a theory developed by psychologist Albert Bandura, refers to an individual's belief in their ability to achieve specific outcomes. Students with high self-efficacy in mathematics believe they can solve mathematical problems and succeed in math-related tasks. This confidence, or lack thereof, profoundly impacts a student's willingness to engage with difficult material. Students with low self-efficacy tend to avoid challenging problems, reinforcing their belief that they cannot succeed. In contrast, students with high self-efficacy are more likely to persist, even when faced with failure (Tang, 2019).

Incorporating self-efficacy into the Mathematical Resilience Framework (MRF) can help students build the confidence necessary to tackle difficult mathematical tasks. When students believe they can succeed, they are more willing to take risks, make mistakes, and learn from their errors. Educators can foster self-efficacy by providing positive reinforcement, setting attainable goals, and offering constructive feedback emphasizing effort over innate ability (Rahman, Mushlihuddin, Refugio, & Zulnaidi, 2024).

Cognitive-behavioral techniques (CBT), which are often used to address anxiety disorders, also play a significant role in building mathematical resilience. CBT focuses on helping individuals identify and challenge negative thought patterns and replace them with more positive, adaptive thoughts (Ojo, Oginni, Akinrinola, & Oginni, 2023). In the context of math anxiety, students often experience negative thoughts such as "I am not good at math" or "I will never understand this." These thoughts contribute to avoidance behaviors and reinforce a sense of helplessness. Educators can use CBT techniques to help students reframe these negative beliefs into more constructive thoughts like "I can improve with practice" or "It is okay to make mistakes" (Minahan, 2019).

Cognitive-behavioral techniques also encourage students to break down complex tasks into smaller, manageable steps, which can reduce feelings of overwhelm. This approach is particularly effective in mathematics, where students may feel intimidated by the complexity of problems (Josefowitz & Myran, 2021). By guiding students to tackle problems one step at a time, educators can help them build confidence and resilience. Additionally, CBT encourages students to practice relaxation techniques, such as deep breathing or mindfulness, to help manage the physical symptoms of anxiety. When combined, self-efficacy and cognitive-behavioral techniques provide a powerful toolkit for fostering mathematical resilience in students (Gillihan, 2020).

2.2. Importance of Fostering Resilience to Reduce Anxiety in Mathematics

Fostering mathematical resilience is essential for reducing anxiety and improving mathematics performance. As previously mentioned, math anxiety can severely impair a student's ability to engage with mathematical tasks. The stress and fear associated with math can prevent students from fully utilizing their cognitive resources, particularly working memory, which is crucial for solving problems and understanding complex concepts. By building resilience, students can learn to manage these feelings of anxiety and stay engaged with the material, even when they encounter difficulties (Haase, Guimarães, & Wood, 2019).

One of the primary benefits of fostering mathematical resilience is the shift in mindset it encourages. Rather than viewing math as an inherently difficult subject in which they are likely to fail, students begin to see challenges as opportunities for growth. This shift is critical for long-term success, as it helps students develop a positive relationship with mathematics. When students are resilient, they are more likely to seek help when needed, collaborate with peers, and remain persistent in the face of setbacks (Samuel, Buttet, & Warner, 2023).

Additionally, fostering resilience can help break the cycle of avoidance that often accompanies math anxiety. When students avoid engaging with math, they miss out on opportunities to practice and improve. This avoidance reinforces

their belief that they are not capable of succeeding, which in turn increases their anxiety. Educators can help students confront their fears and develop the skills necessary for success by teaching them to approach math with resilience (Shayer, 2020).

Improved performance is another direct outcome of fostering mathematical resilience. Students who are willing to engage with challenging problems and persist through difficulties are more likely to develop a deeper understanding of mathematical concepts. This persistence, combined with the cognitive and emotional tools provided by self-efficacy and CBT techniques, allows students to improve their problem-solving skills over time. As their performance improves, their confidence grows, further reinforcing their resilience (Tusianah et al., 2021).

3. Components of the Mathematical Resilience Framework (MRF)

3.1. Detailed Breakdown of the MRF's Key Components

The Mathematical Resilience Framework consists of several core components, each addressing different aspects of learning and anxiety management. These components are:

Cognitive-behavioral techniques (CBT): This element helps students recognize and change negative thought patterns that contribute to math anxiety. By replacing harmful thoughts with constructive ones, students can reduce their feelings of fear and helplessness (Joyce-Beaulieu & Sulkowski, 2019).

Self-efficacy models: Self-efficacy, or the belief in one's ability to succeed, is a critical factor in mathematical resilience. Students who develop a sense of self-efficacy are more likely to tackle challenging problems with confidence and persistence (Waluya, 2020).

Growth mindset: The belief that intelligence and abilities can be developed through effort is central to building resilience. This mindset shifts students' focus from fearing failure to viewing struggles as opportunities for learning.

Emotional regulation: Learning to manage stress and anxiety is crucial for students who experience math anxiety. Techniques such as mindfulness, deep breathing, and relaxation exercises help students maintain focus and calm during stressful tasks (Buckley & Sullivan, 2023).

Collaborative learning: While not always emphasized, working with peers can foster resilience by creating a supportive environment where students can share strategies, face challenges together, and receive encouragement (Kunnari, Ilomäki, & Toom, 2018).

These components are not meant to function in isolation; instead, they work in concert to help students develop the skills and mindset necessary to persevere through the challenges of learning mathematics.

3.2. Cognitive-Behavioral Techniques and Their Application in MRF

Cognitive-behavioral techniques are integral to the MRF, as they directly address the negative thinking patterns that contribute to math anxiety. Many students with math anxiety have automatic thoughts like "I am not good at math" or "I will fail this test." These thoughts are not only self-defeating but also exacerbate anxiety, making it difficult for students to focus or engage in problem-solving. CBT helps students challenge and reframe these beliefs, replacing them with more positive, realistic ones such as "I can improve with practice" or "It is okay to make mistakes as part of the learning process" (Saraf, Rahman, Jimenez Gallardo, Jamison, & Lor, 2018).

In the MRF, CBT is applied by teaching students to identify these harmful thoughts and guiding them through strategies to replace them with more constructive thinking. For example, students may be asked to keep a journal of their thoughts when they encounter difficult math problems and then work with a teacher or counselor to challenge these thoughts. Over time, students learn to recognize patterns in their thinking and develop the tools to manage their anxiety.

Another important aspect of CBT in the MRF is the use of graded exposure. This technique gradually exposes students to increasingly challenging mathematical tasks in a controlled, supportive environment. Students' confidence grows and anxiety diminishes as they successfully complete these tasks. This approach helps students realize that they can succeed in math, even when difficult, reinforcing resilience.

3.3. Integration of Self-Efficacy Models within the Framework

Self-efficacy is a critical component of the MRF, as it directly influences a student's willingness to engage with challenging math problems. Students with high self-efficacy are more likely to persist in the face of difficulty, while those with low self-efficacy tend to avoid math tasks altogether. The MRF incorporates self-efficacy models by focusing on building students' confidence in their mathematical abilities (Tseeke, 2021).

One way this is achieved is through goal-setting and positive reinforcement. Students are encouraged to set specific, achievable goals for their math learning, such as mastering a particular type of problem or improving their test scores. When students achieve these goals, they receive positive feedback that reinforces their belief in their ability to succeed. This feedback loop is essential for building self-efficacy over time (El-Adl & Alkharusi, 2020). Additionally, the MRF emphasizes the importance of modeling. When students see their peers or teachers successfully engaging with difficult math tasks, it strengthens their belief that they, too, can succeed. Teachers play a key role in this process by demonstrating problem-solving techniques, sharing their experiences with math learning, and offering encouragement (Morrison et al., 2021).

3.4. Role of Mindset and Emotional Regulation in Overcoming Anxiety

Mindset plays a fundamental role in the MRF, particularly the concept of a growth mindset, which is the belief that abilities can be developed through effort and persistence. Students who adopt a growth mindset are more likely to view math challenges as learning opportunities rather than threats to their self-worth. This shift in perspective is crucial for reducing math anxiety, as it helps students focus on the process of learning rather than the outcome of success or failure (Wakefield, 2019).

The MRF also includes strategies for emotional regulation, as managing stress and anxiety is a key factor in developing resilience. Students who experience math anxiety often have physical symptoms of stress, such as increased heart rate, shallow breathing, or difficulty concentrating. By incorporating techniques such as deep breathing, mindfulness, and progressive muscle relaxation, the MRF helps students calm their physiological responses to anxiety, allowing them to focus on the task at hand.

In addition to these techniques, the MRF encourages students to practice self-compassion. When students are kind to themselves in moments of difficulty, they are less likely to experience the intense stress that exacerbates math anxiety. Self-compassion involves recognizing that struggle is a normal part of learning and that making mistakes is a valuable part of learning (Frey, Fisher, & Smith, 2019).

The components of the MRF are interdependent and work together to provide comprehensive support for students dealing with math anxiety. For example, cognitive-behavioral techniques help students reframe negative thoughts, which in turn boosts their self-efficacy. As students begin believing in their ability to succeed, they are more likely to adopt a growth mindset, further reinforcing their willingness to engage with difficult tasks. Emotional regulation techniques support this process by helping students manage the physical and emotional symptoms of anxiety, allowing them to remain calm and focused during challenging tasks (Broderick, 2021).

The synergy between these components is what makes the MRF an effective tool for reducing math anxiety and fostering resilience. As students build their cognitive and emotional skills, they become better equipped to face mathematical challenges without being overwhelmed by fear or doubt. Over time, this leads to improved performance, greater confidence, and a more positive relationship with mathematics (McKay, Wood, & Brantley, 2019).

4. Application and Implications of the Mathematical Resilience Framework

4.1. Potential Benefits of Applying MRF in Educational Settings

One of the most significant benefits of applying the MRF in educational settings is its ability to reduce math anxiety and improve students' confidence in their mathematical abilities. Math anxiety is a widespread problem that affects a large percentage of students across different educational levels (Zhang, Zhao, & Kong, 2019). This anxiety impairs students' ability to perform well in math-related tasks and discourages them from pursuing careers in science, technology, engineering, and mathematics (STEM) fields. By targeting both the cognitive and emotional factors that contribute to math anxiety, the MRF provides students with the tools they need to develop resilience and maintain motivation, even when faced with challenging mathematical concepts (Luttenberger et al., 2018).

The framework's focus on cognitive-behavioral techniques helps students recognize and change negative thought patterns that often lead to avoidance of math. When students learn to reframe their fears and doubts, they can approach problems with a clearer mindset, making them more likely to persist through difficulties. This change in attitude can lead to improved academic performance, as students who feel capable of success are more likely to engage in active problem-solving and deep learning strategies.

Furthermore, the emphasis on self-efficacy within the MRF helps students develop a belief in their ability to succeed. When students feel confident in their mathematical skills, they are more willing to take risks, ask questions, and seek help when necessary. This increase in self-efficacy fosters a sense of ownership over the learning process, which can lead to higher levels of achievement and a greater sense of satisfaction with their progress in math (Rahman et al., 2024). In addition to the individual benefits for students, the MRF also offers broader implications for educational institutions. Schools can improve overall student engagement and reduce dropout rates in math-intensive subjects by reducing math anxiety and fostering resilience. This is particularly important as global demand for skills in STEM fields continues to grow, making it critical for educational institutions to prepare students for these career paths (Kao, Wu, Chang, Chien, & Mou, 2020).

4.2. Implementing MRF to Boost Student Engagement and Achievement

Educators are critical in implementing the MRF to improve student engagement and learning outcomes. The framework is designed to adapt to different educational contexts, allowing teachers to integrate its components into their teaching practices. One of the key strategies for implementation is fostering a supportive classroom environment where students feel safe to express their anxieties and challenges. Educators can encourage open discussions about math anxiety, helping students recognize that they are not alone in their struggles and that there are effective ways to manage their anxiety (Cheng, 2019).

Educators can incorporate cognitive-behavioral techniques into their instruction to apply the MRF. For example, teachers can guide students through exercises that help them identify negative thought patterns and replace them with more constructive ones. Journaling, reflection activities, and group discussions about students' experiences with math can all be used to create a space for addressing cognitive barriers to learning. Additionally, educators can use scaffolding techniques, gradually increasing the difficulty of math tasks so that students can build their confidence step by step (Priyo & Teguh, 2021).

Another critical component of implementing the MRF is promoting self-efficacy. Teachers can do this by setting clear, achievable goals for their students and providing consistent feedback that reinforces their progress. Celebrating small wins, such as mastering a specific type of problem or improving a test score, helps students see tangible evidence of their abilities. Educators can also model problem-solving strategies, demonstrating that mistakes are part of learning and showing students how to approach challenging problems with resilience (Kang, Kim, & Chung, 2019).

Mindset interventions are another practical method for educators to employ the MRF. Encouraging a growth mindset—the belief that mathematical ability can be developed through effort and persistence—can transform how students approach their math learning. Teachers can provide opportunities for students to engage in challenging tasks, praising their effort rather than focusing solely on correct answers. This approach helps shift students' focus from fear of failure to the process of learning and improvement.

Finally, emotional regulation strategies such as mindfulness exercises, deep breathing, and stress management techniques can be incorporated into the classroom. Educators can begin math lessons with short relaxation exercises to help students calm their nerves and enter a state of focused attention. These techniques reduce anxiety and enhance students' ability to concentrate and retain information (Jackson, 2018).

4.3. Comparison with Other Interventions for Math Anxiety and Their Limitations

While the MRF offers a comprehensive approach to overcoming math anxiety, other interventions have been developed with similar goals in mind. Traditional approaches to addressing math anxiety often focus on tutoring or skill-building exercises that aim to improve students' math competencies. While these interventions can be helpful, they often fail to address the emotional and cognitive barriers that prevent students from fully engaging in math. For example, a student may receive additional math tutoring but still struggle with anxiety and low self-confidence, leading to continued avoidance of math tasks.

One common intervention is relaxation training, where students are taught specific techniques to calm their nerves before engaging in math tasks. While relaxation techniques can be effective in reducing immediate feelings of anxiety,

they do not necessarily provide students with the cognitive tools they need to change their negative thought patterns. As a result, students may continue to experience anxiety when faced with new or more challenging math tasks.

Another intervention is the use of math apps or games that aim to make learning math more enjoyable and interactive. While these tools can be valuable in increasing student engagement, they often do not address the deeper psychological factors contributing to math anxiety. Without a focus on mindset, self-efficacy, and emotional regulation, these interventions may only provide temporary relief from anxiety rather than fostering long-term resilience (Tabibnia & Radecki, 2018).

The MRF stands out from these other interventions because it takes a holistic approach to math anxiety. It not only addresses the immediate symptoms of anxiety but also provides students with the cognitive and emotional skills necessary to overcome it in the long term. By focusing on resilience, the MRF helps students build a foundation for success in math that extends beyond the classroom and into their future academic and professional pursuits (Schinke, Stambulova, Si, & Moore, 2018).

5. Conclusion

The Mathematical Resilience Framework represents a novel and comprehensive approach to addressing math anxiety, a widespread issue that affects students' academic performance and long-term engagement with mathematics. By combining cognitive-behavioral techniques with self-efficacy models, the MRF offers students the tools they need to overcome their fear of math and develop resilience in the face of challenges. Throughout this paper, the MRF has been discussed in terms of its components, application, and potential benefits, all of which point to its effectiveness in reducing math anxiety and fostering a positive relationship with the subject.

One of the key insights from this paper is the importance of addressing both the emotional and cognitive aspects of math anxiety. Traditional interventions often focus solely on improving students' mathematical skills without recognizing the deeper psychological barriers that prevent students from succeeding. The MRF, in contrast, takes a holistic approach, providing students with strategies to regulate their emotions, challenge negative thought patterns, and build confidence in their abilities. This multifaceted approach helps students improve their math performance and encourages long-term engagement with mathematics, making it a valuable framework for educators and students.

Another key takeaway is the role of educators in the successful implementation of the MRF. Teachers are at the forefront of creating supportive learning environments where students feel comfortable expressing their anxieties and working through them. By incorporating cognitive-behavioral techniques, fostering a growth mindset, and promoting self-efficacy, educators can help students develop the resilience they need to persevere in math. The MRF emphasizes that math success is not solely about mastery of content, but also about fostering a positive emotional and cognitive relationship with the subject.

The potential for the MRF to improve math outcomes extends beyond individual classrooms to the broader educational system. By reducing math anxiety and improving students' resilience, the framework can contribute to higher retention rates in STEM-related fields and help close the gap in math performance across different demographics. This has important implications for workforce development in a world that increasingly values math and analytical skills.

5.1. Recommendations for Educators, Policymakers, and Researchers

A collaborative effort between educators, policymakers, and researchers is essential to integrate the MRF into educational settings effectively. The following recommendations aim to guide these stakeholders in implementing the MRF to maximize its benefits. Teachers should receive training on the components of the MRF, particularly on how to incorporate cognitive-behavioral techniques, self-efficacy models, and mindset interventions into their teaching practices. Professional development programs should focus on equipping educators with practical strategies to help students manage their math anxiety. Additionally, educators should create classroom environments that encourage open discussions about math anxiety, allowing students to express their concerns and work through them collaboratively.

Educational policies should support the integration of frameworks like the MRF into the curriculum. Policymakers can promote this by allocating resources for teacher training, developing curriculum materials that incorporate resilience-building activities, and emphasizing the importance of addressing math anxiety as part of student well-being. Policies should also encourage early intervention, ensuring that students struggling with math anxiety receive the support they need before their anxiety becomes a significant barrier to learning.

Further research is needed to evaluate the effectiveness of the MRF across different student populations and educational contexts. Longitudinal studies can provide insight into the long-term benefits of the MRF and its potential to reduce math anxiety at various educational levels. Additionally, researchers should explore how the MRF can be adapted in different cultures and learning environments, ensuring its principles apply in diverse educational settings.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Boaler, J. (2022). Mathematical mindsets: Unleashing students' potential through creative mathematics, inspiring messages and innovative teaching: John Wiley & Sons.

[2] Broderick, P. C. (2021). Learning to breathe: A mindfulness curriculum for adolescents to cultivate emotion regulation, attention, and performance: new harbinger publications.

[3] Buckley, S., & Sullivan, P. (2023). Reframing anxiety and uncertainty in the mathematics classroom. Mathematics Education Research Journal, 35(Suppl 1), 157-170.

[4] Cheng, Y. C. (2019). Paradigm shift in education: Towards the third wave of effectiveness: Routledge.

[5] Derling, M., Magda, C., Gabriela, R., & Carmen, V. (2021). Anxiety as a prevailing factor of performance of university mathematics students during the COVID-19 pandemic. Образование и наука, 23(2), 94-113.

[6] El-Adl, A., & Alkharusi, H. (2020). Relationships between self-regulated learning strategies, learning motivation and mathematics achievement. Cypriot Journal of Educational Sciences, 15(1), 104-111.

[7] Frey, N., Fisher, D., & Smith, D. (2019). All learning is social and emotional: Helping students develop essential skills for the classroom and beyond: Ascd.

[8] Gillihan, S. J. (2020). Cognitive behavioural therapy made simple: 10 strategies for managing anxiety, depression, anger, panic and worry: Hachette UK.

[9] Haase, V. G., Guimarães, A. P. L., & Wood, G. (2019). Mathematics and emotions: The case of math anxiety. International handbook of mathematical learning difficulties: From the laboratory to the classroom, 469-503.

[10] Jackson, R. R. (2018). Never work harder than your students and other principles of great teaching: ASCD.

[11] Johnston-Wilder, S., & Moreton, J. (2018). Developing mathematical-resilience-promoting practices in teachers. Paper presented at the ICERI2018 Proceedings.

[12] Josefowitz, N., & Myran, D. (2021). CBT Made Simple: A Clinician's Guide to Practicing Cognitive Behavioral Therapy: New Harbinger Publications.

[13] Joyce-Beaulieu, D., & Sulkowski, M. L. (2019). Cognitive behavioral therapy in K-12 school settings: A practitioner's workbook: Springer Publishing Company.

[14] Kang, S.-K., Kim, H.-m., & Chung, M.-R. (2019). Mediating effect of ego-resiliency in the relationship between growth mindset and pregnancy stress. Journal of the Korean Society of Maternal and Child Health, 23(2), 126-135.

[15] Kao, C.-P., Wu, Y.-T., Chang, Y.-Y., Chien, H.-M., & Mou, T.-Y. (2020). Understanding web-based professional development in education: The role of attitudes and self-efficacy in predicting teachers' technology-teaching integration. The Asia-Pacific Education Researcher, 29(5), 405-415.

[16] Kunnari, I., Ilomäki, L., & Toom, A. (2018). Successful teacher teams in change: The role of collective efficacy and resilience. International Journal of Teaching and Learning in Higher Education, 30(1), 111-126.

[17] Lee, M. (2021). Mindsets: Case Studies on Incremental and Entity Theories in Undergraduate Music Students: University of Toronto (Canada).

[18] Luttenberger, S., Wimmer, S., & Paechter, M. (2018). Spotlight on math anxiety. Psychology research and behavior management, 311-322.

[19] Mammarella, I. C., Caviola, S., & Dowker, A. (2019). Mathematics anxiety. Oxon: Routledge.

[20] McKay, M., Wood, J. C., & Brantley, J. (2019). The dialectical behavior therapy skills workbook: Practical DBT exercises for learning mindfulness, interpersonal effectiveness, emotion regulation, and distress tolerance: New Harbinger Publications.

[21] Minahan, J. (2019). Tackling negative thinking in the classroom. Phi Delta Kappan, 101(3), 26-31.

[22] Morrison, J., Frost, J., Gotch, C., McDuffie, A. R., Austin, B., & French, B. (2021). Teachers' role in students' learning at a project-based STEM high school: Implications for teacher education. International Journal of Science and Mathematics Education, 19, 1103-1123.

[23] Ojo, A., Oginni, O. G., Akinrinola, O. E., & Oginni, R. I. (2023). Impact of cognitive-behavioral intervention on alleviating depression and anxiety in mathematics: Enhancing students' learning experience and academic performance. Voice of the Publisher, 9(04), 257-271.

[24] Palmer, N. (2023). A Study of the Relationship Between High School Mathematics Preparation, Math Anxiety, and Student Self-Efficacy on First-Generation Student Success in College Mathematics: University of Louisiana at Lafayette.

[25] Priyo, U. D., & Teguh, S. (2021). Zone of proximal development and scaffolding required by junior high school students in solving mathematical problems. Образование и наука, 23(9), 186-202.

[26] Rahman, A. A., Mushlihuddin, R., Refugio, C. N., & Zulnaidi, H. (2024). Problem-based learning innovation through realism and culture: Impact on mathematical problem solving and self-efficacy in primary school students. Al-Jabar: Jurnal Pendidikan Matematika, 15(1).

[27] Ross, P. M., Scanes, E., Poronnik, P., Coates, H., & Locke, W. (2022). Understanding STEM academics' responses and resilience to educational reform of academic roles in higher education. International journal of STEM education, 9(1), 11.

[28] Samuel, T. S., Buttet, S., & Warner, J. (2023). "I Can Math, Too!": Reducing Math Anxiety in STEM-Related Courses Using a Combined Mindfulness and Growth Mindset Approach (MAGMA) in the Classroom. Community College Journal of Research and Practice, 47(10), 613-626.

[29] Saraf, P., Rahman, T., Jimenez Gallardo, M. A., Jamison, J. C., & Lor, C. (2018). Improving mental well-being and productivity of small-medium entrepreneurs in fragile, conflict and violence affected areas: can cognitive behavioral therapy trainings help? World Bank Policy Research Working Paper(8489).

[30] Schinke, R. J., Stambulova, N. B., Si, G., & Moore, Z. (2018). International society of sport psychology position stand: Athletes' mental health, performance, and development. International journal of sport and exercise psychology, 16(6), 622-639.

[31] Shayer, L. P. (2020). Math anxiety and contemplative practices in post-secondary contexts. University of British Columbia,

[32] Tabibnia, G., & Radecki, D. (2018). Resilience training that can change the brain. Consulting Psychology Journal: Practice and Research, 70(1), 59.

[33] Tang, T. (2019). Fragile strength: Math self-efficacy of high achieving girls.

[34] Tomasetto, C., Morsanyi, K., Guardabassi, V., & O'Connor, P. A. (2021). Math anxiety interferes with learning novel mathematics contents in early elementary school. Journal of Educational Psychology, 113(2), 315.

[35] Tseeke, M. (2021). Teachers' perceived self-efficacy in responding to the needs of learners with visual impairment in Lesotho. South African Journal of Education, 41(2), S1-S12.

[36] Tusianah, R., Sutarsyah, C., Sukirlan, M., Ridwan, R., Nurmalisa, Y., Isnainy, U. C., . . . Puja Kesuma, T. A. R. (2021). An integrative review of self-efficacy: What factors enhance and impair it? WSEAS Transactions on Business and Economics, 18, 1057-1072.

[37] Wakefield, M. C. (2019). An examination of mindset and academic growth of middle school science students. Regent University,

[38] Waluya, S. (2020). Mathematical representation ability and self-efficacy. Paper presented at the Journal of Physics: Conference Series.

[39] Zhang, J., Zhao, N., & Kong, Q. P. (2019). The relationship between math anxiety and math performance: A meta-analytic investigation. Frontiers in psychology, 10, 1613.

[40] Živković, M., Pellizzoni, S., Mammarella, I. C., & Passolunghi, M. C. (2023). The relationship betweens math anxiety and arithmetic reasoning: The mediating role of working memory and self-competence. Current Psychology, 42(17), 14506-14516.