



An Integrative Model of Mathematical Well-Being and Anxiety Reduction (I-WARM): Evidence from Teachers' and Students' Perspectives

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Abstract: This study aims to develop an Integrative Model of Mathematical Well-Being and Anxiety Reduction (I-WARM) based on the perspectives of secondary school teachers and students in Kupang City, Indonesia. A mixed-methods sequential exploratory design was employed, involving 211 students and 32 mathematics teachers. Quantitative data were collected through Likert-scale questionnaires to measure levels of mathematical well-being and mathematics anxiety, while qualitative data explored pedagogical practices and classroom environments that support students' well-being. Quantitative data were analyzed using descriptive statistics to describe the level of each variable, instrument validity and reliability tests (through item-total correlation and Cronbach's Alpha), and Pearson correlation analysis. Meanwhile, qualitative data were analyzed using thematic analysis techniques through the processes of data reduction, coding, categorization, and conclusion drawing. The findings indicate that students' mathematical well-being was at a moderate to high level, whereas mathematics anxiety was at a moderate level. Correlation analysis revealed a significant negative relationship between mathematical well-being and mathematics anxiety ($r = -0.236$, $p < 0.05$). Qualitative results highlight autonomy-supportive teaching, competence development, and social relatedness as key protective factors against mathematics anxiety. By synthesizing Self-Determination Theory and Control-Value Theory, the proposed I-WARM model provides a conceptual roadmap for educators to foster resilient learning environments. These findings suggest that reducing anxiety requires a shift from deficit-based interventions to well-being-centered pedagogical strategies.

Article History

Received: 13-01-2026

Revised: 16-02-2026

Accepted: 28-02-2026

Published: 25-03-2026

Key Words:

Mathematical Well-Being;
Mathematics Anxiety;
Integrative Model; I-
WARM; Secondary
Education.

How to Cite: Aba, M. M., Baiduri, Inganah, S., & Wula, Z. (2026). An Integrative Model of Mathematical Well-Being and Anxiety Reduction (I-WARM): Evidence from Teachers' and Students' Perspectives. *Jurnal Kependidikan : Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran, Dan Pembelajaran*, 12(1), 399-410. <https://doi.org/10.33394/jk.v12i1.19688>



<https://doi.org/10.33394/jk.v12i1.19688>

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Introduction

Student well-being and mathematics anxiety are important issues in modern education. Mathematics plays a strategic role in developing logical, analytical, and problem-solving skills; however, for many students, this subject becomes a significant source of anxiety (Lucietto & Rada, 2022; Murtiyasa & Djumadi, 2023). Mathematics anxiety not only affects academic achievement but also undermines emotional well-being, reduces learning motivation, and limits students' academic potential (Ulum & Küçükdanacı, 2022; Jameson et al., 2022).

In the global context, improving the quality of mathematics education is no longer measured solely by academic achievement but also by students' well-being (Szczygieł, 2023). The PISA 2022 results indicate a global decline in mathematics performance, with the OECD average mathematics score dropping by approximately 16 points compared to 2018, a setback described by the OECD as "unprecedented." In parallel, the report also notes that about 65% of OECD students reported anxiety about their mathematics performance and 40% felt



nervous or helpless when solving mathematics problems, and higher levels of anxiety were associated with lower mathematics achievement. These findings underscore that affective factors play a significant role in mathematics learning outcomes across countries (*Full Report*, 2023). In contrast, recent studies have introduced the concept of mathematical well-being (MWB) as a positive condition encompassing self-confidence, motivation, and a sense of meaning in mathematics learning (Hill et al., 2021; Mammarella et al., 2023).

Research in Indonesia has rarely examined the relationship between mathematical well-being and mathematics anxiety in an integrated manner. Most existing studies focus on cognitive factors or the relationship between anxiety and academic achievement (Salahot, 2022; Ali, 2023), while emotional and motivational well-being has received less attention. In the Indonesian context, particularly in eastern regions such as East Nusa Tenggara, mathematics anxiety remains a serious challenge. Preliminary observations indicate that most senior high school students in Kupang City experience mathematics anxiety at a moderate level, with evaluative and cognitive aspects as the primary sources. Students tend to fear failure, lack self-confidence, and experience emotional tension when facing mathematics tasks. At the same time, teachers have begun to recognize the importance of students' emotional well-being as a prerequisite for meaningful learning. This condition suggests that mathematics instruction has not yet fully addressed students' affective dimensions. Teachers tend to emphasize academic outcomes over psychological well-being, even though mathematical well-being can function as a protective factor in reducing anxiety and enhancing learning engagement.

Most previous studies have examined mathematical well-being and mathematics anxiety separately, without exploring their conceptual or empirical relationship (Dowker et al., 2016; Szucs & Toffalini, 2023). Moreover, existing anxiety-reduction models tend to adopt a deficit-oriented approach focused on symptom management, resulting in limited integration with classroom pedagogy and a lack of systematic efforts to foster students' well-being. Frameworks such as Self-Determination Theory (Ryan & Deci, 2020) and Control-Value Theory (Pekrun, 2024) are also frequently examined independently, without being synthesized into a comprehensive model specifically designed for mathematics education. This condition indicates a conceptual gap in developing an integrative framework that simultaneously enhances mathematical well-being and reduces anxiety. To address this gap, the present study develops the Integrative Well-Being and Anxiety Reduction Model (I-WARM), which integrates pedagogical, psychological, and social dimensions to explain the role of mathematical well-being as a protective mechanism against students' mathematics anxiety.

Research Method

This study used a mixed-methods approach with a sequential exploratory design, beginning with quantitative data to map levels of mathematical well-being (MWB) and mathematics anxiety, followed by qualitative exploration to deepen the findings. Quantitative data were collected through Likert-scale questionnaires, while qualitative data were obtained from open-ended questions and analyzed thematically. This design enabled integration of numerical and narrative results to develop the I-WARM Model. The research was conducted in 10 senior high schools in Kupang City (3 public, 5 private, 2 vocational) using purposive sampling. Participants included 211 Grade 10–11 students and 32 mathematics teachers selected based on relevant criteria such as academic variation and teaching experience. All participants provided informed consent. The main variables in this study were mathematical well-being (MWB) with seven dimensions according to Hill, and four aspects of mathematics

anxiety—affective, cognitive, physiological, and behavioral (Ramirez et al., 2018) as well as contextual factors including social support, teaching strategies, and classroom climate.

Data were collected using five-point Likert questionnaires initially containing 24 items; after validity and reliability testing, 21 valid items remained for both student and teacher versions. Open-ended questions explored needed support, teacher roles, and strategies for fostering well-being. Instruments were grounded in Mathematical Well-Being Theory, Control-Value Theory, and Self-Determination Theory. Validity was established through expert judgment (≥ 3.00), Pearson correlation for empirical validity, and Cronbach's alpha (≥ 0.70) for reliability. Quantitative data were analyzed using descriptive statistics, factor analysis, and Pearson correlation to examine relationships between MWB and anxiety. Qualitative data were analyzed thematically following credibility, dependability, and confirmability principles. Findings from both phases were integrated through triangulation to construct the conceptual I-WARM Model.

Results and Discussion

Results

1) Mathematical Well-Being from Teachers' and Students' Perspectives

The research data related to mathematical well-being from teachers' and students' perspectives are visualized in Figures 1 and Figure2 below.



Figure 1. Teachers' Perspectives on Mathematical Well-Being

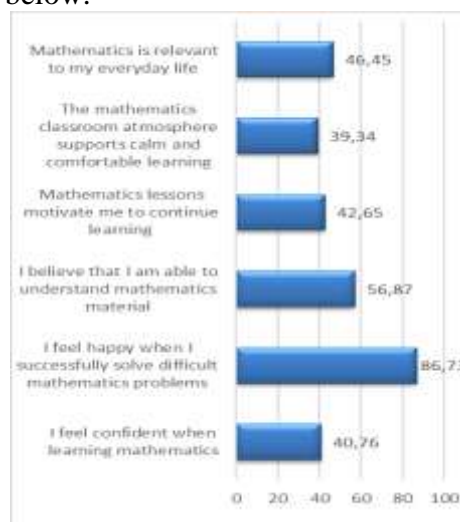


Figure 2. Students' Perspectives on Mathematical Well-Being

The findings show that teachers demonstrate very strong optimism regarding the importance of students' mathematical well-being. Almost all teachers (96.88%) prioritize well-being in instruction and believe they have created supportive classrooms, while 93.75% are convinced that well-being reduces anxiety and enhances motivation. This reflects high pedagogical commitment and awareness of the emotional dimension of mathematics learning.

However, students' responses present a more nuanced picture. Although 86.73% feel happy when successfully solving difficult problems—indicating that achievement strongly shapes their well-being—only 56.87% feel confident in understanding the material. Even fewer perceive mathematics as relevant to daily life (46.45%), and less than half experience a calm, comfortable classroom atmosphere (39.34%) or report strong self-confidence and enthusiasm for further learning.

These results suggest a gap between teachers' intentions and students' lived experiences. While teachers emphasize emotional support and a positive climate, students

associate well-being more with competence, meaningful understanding, and real-life relevance. This difference in orientation—emotional-social focus from teachers versus cognitive-practical focus from students—forms the core insight of the study and provides an important basis for refining the I-WARM Model to better align with students’ authentic experiences.

2) The Causes of Mathematics Anxiety

The research data on the causes of mathematics anxiety according to teachers’ and students’ perspectives are visually presented in Figure 3 and Figure 4 below.

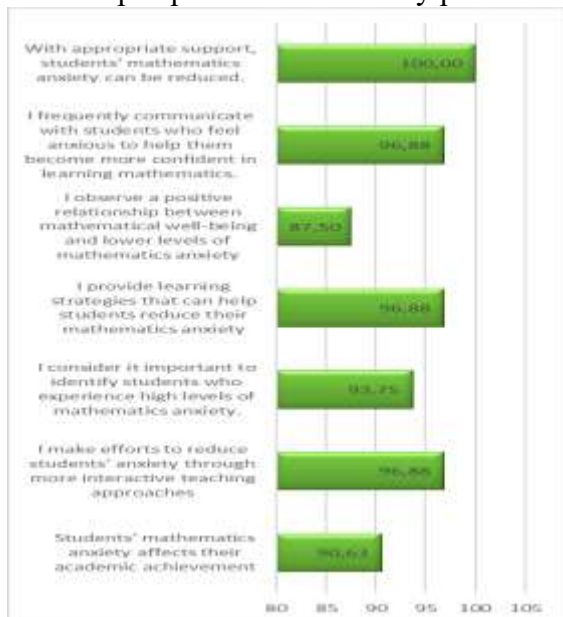


Figure 3. The Main Causes of Mathematics Anxiety from Teachers’ Perspectives

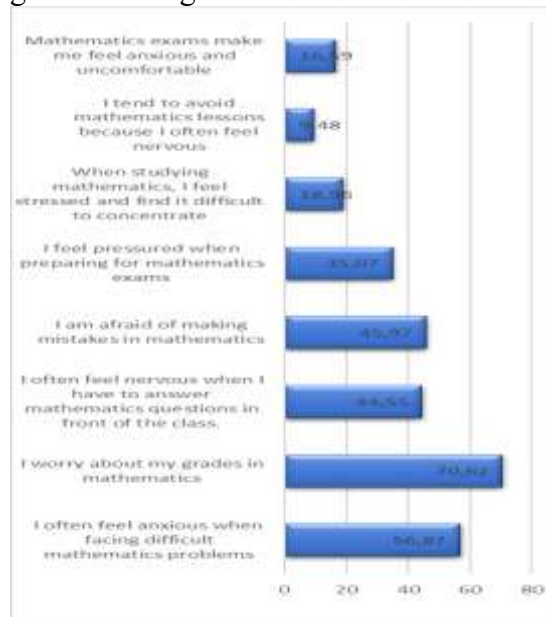


Figure 4. The Main Causes of Mathematics Anxiety from Students Perspectives

The findings indicate that teachers have strong awareness of mathematics anxiety among students. Most teachers (90.63%) believe anxiety affects academic achievement, and 78.13% frequently encounter anxious students. They also show strong commitment to intervention: 96.88% use interactive approaches to reduce anxiety, 93.75% stress early identification of anxious students, and 96.88% actively communicate to build confidence. All agree that anxiety can be reduced with proper support.

From the students’ perspective, anxiety is mainly driven by academic pressure. Concern about grades is the dominant factor (70.62%), followed by difficulty with mathematical problems (56.87%) and fear of making mistakes (45.97%). Situational factors such as answering in class (44.55%) and examinations (35.07%) are less prominent, suggesting anxiety is more evaluative than social. Overall, students’ anxiety centers on self-evaluation and academic pressure, whereas teachers focus on pedagogical strategies and emotional support. This highlights a perceptual gap between the sources of anxiety experienced by students and the interventions emphasized by teachers.

3) Relationship between Mathematical Well-Being and Mathematics Anxiety

The results of the correlation analysis between mathematical well-being and mathematics anxiety were examined using the Pearson Product–Moment correlation with a total of 211 student respondents. The results of the analysis are presented in Table 1 below.

Table 1. Results of the Correlation Analysis

		Well-being	Anxiety
Well-being	Pearson Correlation	1	-.236**
	Sig. (2-tailed)		,001
	N	211	211
Anxiety	Pearson Correlation	-.236**	1
	Sig. (2-tailed)	,001	
	N	211	211

** . Correlation is significant at the 0.01 level (2-tailed).

The results show a correlation coefficient of $r = -0.236$ with $p = 0.001$ ($p < 0.01$), indicating a statistically significant negative relationship between mathematical well-being and mathematics anxiety at the 99% confidence level. This means that higher mathematical well-being is associated with lower anxiety. Although the correlation is weak, it remains significant, suggesting that mathematical well-being contributes to students' anxiety levels. These findings highlight the important emotional role of well-being in mathematics learning and imply that efforts to enhance well-being—such as fostering a positive classroom climate and providing meaningful support may help reduce mathematics anxiety.

4). Teachers' Roles in Creating a Supportive Learning Environment for Mathematical Well-Being

The research data related to teachers' and students' perspectives on the role of teachers in creating a learning environment that supports mathematical well-being are visualized in Figures 5 and Figure 6.

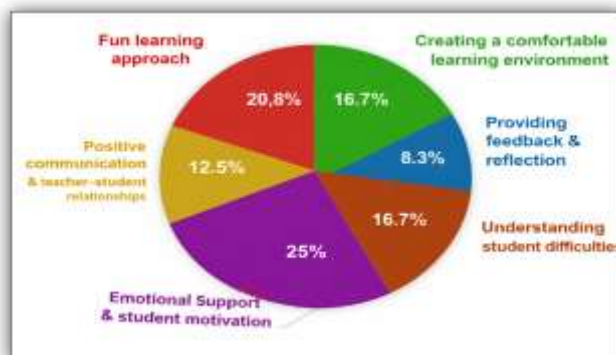


Figure 5. Teachers' Perspectives on Their Role in Creating a Classroom Environment that Supports Mathematical Well-Being

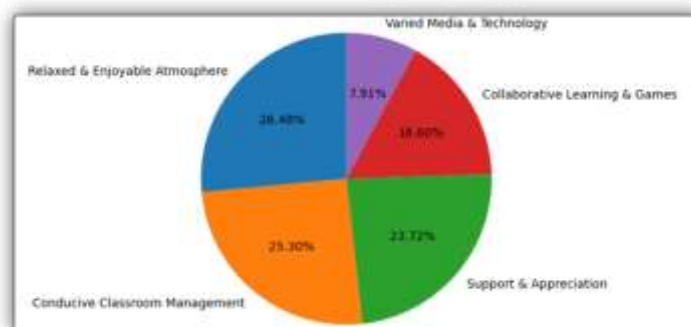


Figure 6. Students' Perspectives on The Teacher's Role in Creating a Classroom Environment that Supports Mathematical Well-Being

The analysis shows that teachers play a strategic role in fostering mathematical well-being and reducing anxiety. Teachers emphasize emotional support and motivation (25%), enjoyable approaches (20.8%), and a comfortable classroom climate (16.7%). They also highlight understanding learning difficulties, maintaining positive communication, and providing reflective feedback—indicating awareness that well-being depends on both academic and psychological support.

Students likewise view teachers as central to creating well-being. They stress the importance of a relaxed classroom atmosphere (26.48%), effective classroom management (25.30%), teacher support and appreciation (23.72%), collaborative activities (16.60%), and varied media use (7.91%). For students, emotional comfort and low pressure are key to reducing anxiety. Overall, both groups agree on two main factors: a positive, enjoyable learning environment and consistent emotional support. This confirms that mathematical well-being is shaped by the integration of emotional, social, and pedagogical dimensions, positioning teachers not only as instructors but also as facilitators of students' emotional security and motivation.

5). Synthesis of Findings as a Foundation for Developing the I-WARM Model

The synthesis of findings as the basis for the development of the I-WARM Model is visualized in Figure 7, below:

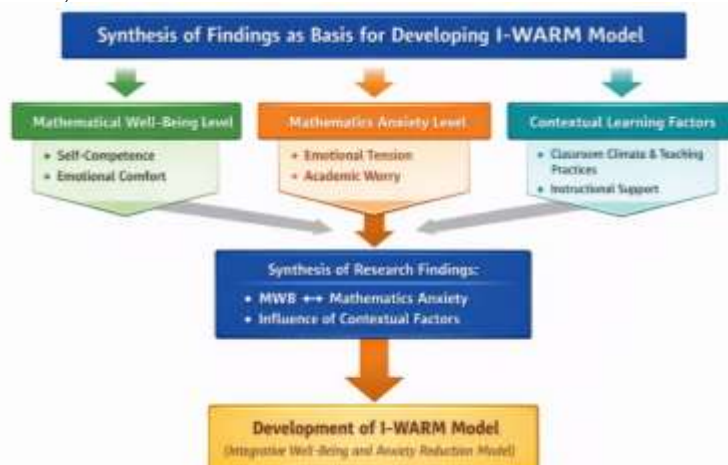


Figure 7. Diagram of the Synthesis of Findings

Figure 7 presents a synthesis of students' mathematical well-being, mathematics anxiety, and contextual learning factors as the empirical basis for developing the I-WARM Model. The findings show that self-competence and emotional comfort are central dimensions of mathematical well-being. Students who perceive themselves as capable and feel emotionally secure experience more positive learning and less pressure, indicating that well-being functions as a protective factor. In contrast, mathematics anxiety is mainly expressed through emotional tension (fear, nervousness) and academic worry (fear of failure and evaluation), affecting both emotions and learning perceptions. Contextual factors—such as classroom climate, instructional practices, and teacher support—significantly influence both well-being and anxiety. Supportive, error-tolerant, and feedback-oriented environments enhance comfort and engagement, whereas pressuring, outcome-focused practices reinforce anxiety.

Overall, the synthesis confirms a consistent negative relationship between mathematical well-being and mathematics anxiety, shaped by contextual factors. This provides a strong empirical foundation for the I-WARM Model, which positions

mathematical well-being as the primary mechanism for reducing anxiety, supported by conducive learning environments.

6). Presentation of the Integrative Well-Being and Anxiety Reduction in Mathematics Model (I-WARM)

Based on empirical findings from teacher and student data, the Integrative Well-Being and Anxiety Reduction in Mathematics (I-WARM) Model was developed. This model identifies sources of mathematics anxiety, the mediating role of teachers, and learning outcomes in the form of enhanced mathematical well-being and reduced mathematics anxiety. The visualization of the I-WARM conceptual model is presented in Figure 8.

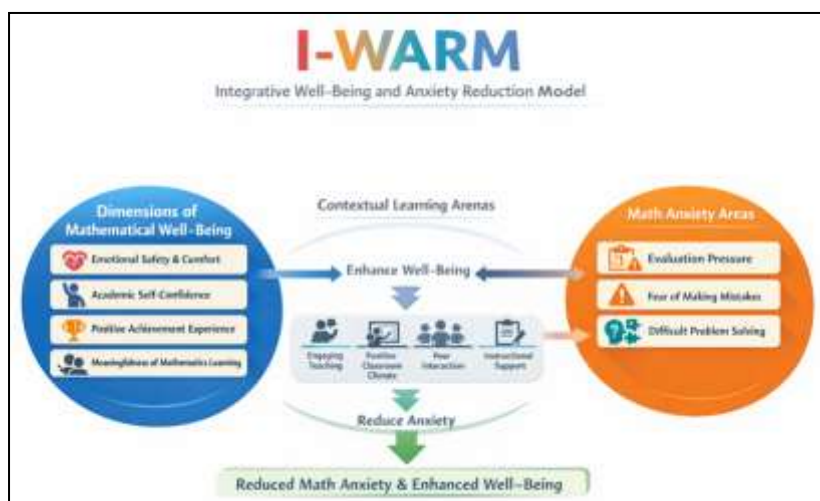


Figure 8. Diagram I-WARM

The visualization of the I-WARM Model in Figure 8 illustrates an integrative relationship among mathematical well-being, learning context, and areas of mathematics anxiety within a unified and interactive conceptual framework. The dimensions of mathematical well-being—including emotional comfort, academic self-confidence, positive experiences of success, and meaningfulness of learning—function as students' internal foundations that are empirically associated with lower levels of mathematics anxiety.

Learning contextual factors, such as enjoyable teaching, a positive classroom climate, collaborative interactions, and teacher support, serve as reinforcing mechanisms that bridge the enhancement of well-being and the reduction of anxiety. These factors emphasize that mathematical well-being is constructed through pedagogical and relational learning experiences. The main areas of anxiety—assessment pressure, fear of making mistakes, and anxiety in facing difficult problems—are positioned as arenas for intervention within the model. Strengthening well-being dimensions and improving the learning context are directed toward reducing these sources of anxiety.

Overall, the I-WARM Model emphasizes that increased mathematical well-being and reduced mathematics anxiety result from systematic interactions between students' internal factors and the learning context, with teachers playing a central role as key facilitators in creating psychologically safe and supportive learning environments.

Discussion

This study provides empirical evidence that mathematical well-being (MWB) plays a protective role against students' mathematics anxiety. The significant negative correlation between MWB and mathematics anxiety ($r = -0.236$; $p < 0.01$) indicates that higher levels of perceived mathematical well-being are associated with lower levels of mathematics anxiety. Although the strength of the relationship is classified as weak according to Cohen's criteria,



its statistical significance confirms that MWB is a relevant affective–psychological factor in students’ mathematics learning experiences.

Nevertheless, the findings of this study also reveal an important contextual nuance. In contrast to several studies conducted in Western contexts, which often position autonomy as the primary predictor of well-being and anxiety reduction (Ryan & Deci, 2017), the present findings indicate that in the Kupang–Indonesia context, the dimension of social relatedness (teacher–student relationships) plays a more dominant role in reducing mathematics anxiety. This suggests that emotional safety and relational support serve as foundational conditions before students develop academic autonomy.

This finding reflects characteristics of collectivistic cultures, in which interpersonal relationships play a central role in fostering courage and academic resilience. In such contexts, students’ confidence in facing mathematics does not rely solely on individual autonomy, but rather on their experience of feeling accepted, understood, and supported by their teachers. Thus, these results not only confirm existing theoretical frameworks but also enrich our understanding of how psychological need dimensions operate in culturally and contextually specific ways.

This finding is also consistent with recent literature emphasizing the close relationship between emotional well-being and academic anxiety. Within the framework of the Control–Value Theory of Achievement Emotions, learning-related emotions, including anxiety, are shaped by students’ perceptions of control and value regarding academic tasks (Pekrun, 2021). Students who perceive higher levels of control and experience more meaningful learning are more likely to report lower levels of anxiety. In this context, MWB can be understood as an indicator of psychological conditions reflecting perceptions of control, meaning, and emotional comfort in mathematics learning.

The results are also consistent with the findings of Ramirez et al., (2018) and (Barroso et al., 2021), which highlight the important role of emotional factors and self-perceptions in the development of mathematics anxiety and academic performance. These studies emphasize that mathematics anxiety is not merely a cognitive issue but a cognitive–emotional phenomenon closely linked to students’ psychological well-being.

Further analysis of MWB dimensions indicates that self-competence and emotional comfort are the most dominant components in shaping students’ mathematical well-being. This finding aligns with Self-Determination Theory (SDT), which posits that competence is a fundamental psychological need that supports intrinsic motivation, engagement, and positive emotions in learning (Ryan & Deci, 2017). When students feel capable and confident in completing mathematical tasks, they are more likely to perceive mathematics as a manageable challenge rather than a threat, thereby reducing anxiety.

The prominence of emotional comfort also underscores the importance of emotional safety in mathematics learning. A safe, supportive, and non-threatening learning environment contributes to the reduction of negative emotions such as anxiety (Pekrun, 2021). Recent research further indicates that a positive classroom climate and teachers’ emotional support are associated with increased positive emotions and decreased anxiety and academic stress (Frenzel et al., 2021).

Although the relationship between MWB and mathematics anxiety is relatively weak, this finding remains theoretically and practically meaningful. Mathematics anxiety is a multidimensional construct influenced by various factors, including cognitive abilities, prior learning experiences, instructional practices, social support, and individual characteristics (Dowker et al., 2016; Carey et al., 2016). Therefore, it is reasonable that MWB explains only part of the variance in mathematics anxiety. Nevertheless, the results indicate that MWB



functions as an emotional buffer that helps students manage academic pressure, even if it does not completely eliminate anxiety.

Based on these empirical findings, the I-WARM Model (Integrative Well-Being and Anxiety Reduction in Mathematics) was developed as a conceptual framework that integrates dimensions of mathematical well-being as protective factors in reducing mathematics anxiety. The model positions MWB dimensions—particularly self-competence, emotional comfort, social connectedness, and a positive learning climate—as foundational conditions that shape students' emotional responses to mathematics learning. Within this framework, high levels of MWB are expected to reduce emotional tension, cognitive worry, and avoidance tendencies, which constitute core components of mathematics anxiety (Carey et al., 2016; Barroso et al., 2021).

Theoretically, the I-WARM Model aligns with the positive psychology paradigm in education and the social-emotional learning approach, both of which emphasize the importance of well-being, supportive relationships, and positive emotions in promoting adaptive academic functioning (Kern et al., 2015; Taylor et al., 2017). Accordingly, the model extends traditional approaches that primarily focus on reducing anxiety symptoms toward a strength-based approach that emphasizes the development of students' psychological resources through the enhancement of mathematical well-being.

The practical implications of these findings suggest that mathematics instruction should not focus solely on cognitive achievement, but also on strengthening students' emotional and psychological dimensions. Teachers and schools can enhance mathematical well-being (MWB) by creating a positive classroom climate, providing constructive feedback to strengthen students' perceptions of competence, and ensuring emotionally safe learning environments. To address the dominance of evaluative anxiety (70.62%), teachers need to implement low-stakes assessments or provide formative feedback that does not directly judge students' abilities, so that evaluation is perceived as part of the learning process rather than as a threat to students' academic self-worth. These practices are consistent with the findings of Wentzel & Miele, (2009) and are further supported by recent research showing that teacher support and a supportive classroom climate contribute to reduced anxiety and increased well-being and learning engagement (Frenzel et al., 2019; Wang et al., 2024).

Overall, this study contributes by empirically demonstrating a significant negative relationship between mathematical well-being and mathematics anxiety and by proposing the I-WARM Model as an integrative framework for understanding and addressing affective aspects of mathematics learning. Although the effect size is relatively small, the findings underscore the importance of integrating well-being-based strategies in mathematics education. Future research is recommended to test the I-WARM Model using longitudinal or experimental designs to examine causal relationships and to evaluate the effectiveness of interventions specifically targeting MWB dimensions in sustainably reducing mathematics anxiety.

Conclusion

This study provides empirical evidence that mathematical well-being (MWB) is negatively and significantly related to mathematics anxiety: higher MWB is associated with lower anxiety. Although the correlation is weak, its significance confirms MWB as an important affective-psychological factor in mathematics learning. Self-competence and emotional comfort emerge as the dominant MWB dimensions, shaping students' sense of ability and emotional security, which in turn help reduce anxiety. This shows that



mathematics anxiety is influenced not only by cognitive factors but also by emotional and psychological conditions.

Based on these findings, the I-WARM Model was developed as an integrative framework that positions MWB as a protective factor against anxiety, strengthened through self-competence, emotional comfort, social connectedness, and a positive learning climate. Practically, mathematics instruction should integrate cognitive goals with emotional support by fostering a supportive classroom climate, providing constructive feedback, and ensuring an emotionally safe learning environment to enhance well-being and reduce anxiety.

Recommendation

Based on the findings, several recommendations are proposed for instructional practice, school policy, and future research. In instructional practice, teachers should place students' emotional well-being at the center of mathematics learning. A humanistic approach that respects individual differences, promotes autonomy, and ensures a safe, low-pressure environment is essential. Growth-mindset feedback emphasizing effort and strategies, along with a culture that treats mistakes as learning opportunities, can reduce anxiety and build confidence. Collaborative methods and interactive media should also be used to enhance engagement and self-efficacy.

At the policy level, schools need to shift from high-stakes testing toward formative assessments that prioritize the learning process. Assessments should encourage reflection, revision, and positive reinforcement so that evaluation supports growth rather than threatens academic self-esteem. Ongoing professional development is also necessary to equip teachers with practical strategies for managing learning anxiety and implementing well-being-oriented pedagogy.

Future research should examine the effectiveness of the I-WARM Model through experimental or quasi-experimental designs, extend its application to other educational levels and subjects, and develop more comprehensive instruments to measure academic well-being and learning anxiety. Overall, this study contributes to mathematics education by integrating academic achievement with emotional well-being. The I-WARM Model is expected to foster healthier, meaningful, and sustainable learning experiences, helping students become both cognitively competent and emotionally resilient in learning mathematics.

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