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Instructional Framework in Addressing Mathematics Anxiety and Learning Engagement Among Grade 9 Students

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Abstract

This study developed an instructional framework to address mathematics anxiety and promote engagement among Grade 9 students. A convergent mixed-method design was employed, combining pretests, posttests, standardized surveys, and a 10-item PISA-type problem-solving test with interviews and classroom observations. Quantitative data were analyzed using descriptive statistics and paired t-tests, while qualitative data underwent content analysis and triangulation.

Results indicated that mathematics anxiety showed little reduction, though students' social engagement became more structured through teacher-facilitated collaboration. Emotional and cognitive engagement improved slightly but not significantly. Thematic analysis identified subject difficulty, low confidence, negative self-perception, and teacher attitudes as key anxiety factors, while collaborative learning, intrinsic motivation, and supportive teachers encouraged positive engagement. Notably, students achieved significant gains in PISA-type problem-solving performance, reflecting enhanced higher-order thinking skills.

The framework demonstrated potential to improve academic outcomes and stabilize engagement but had a limited effect on reducing anxiety. Further refinement should focus on targeted anxiety-reduction strategies and sustained integration of real-world, collaborative learning experiences.

1. INTRODUCTION

Mathematics anxiety remains a significant challenge, negatively influencing students' performance, confidence, and classroom participation. Studies show its widespread impact: Uniyal and Bhardwaj (2021) found no gender differences in anxiety levels, while Mazana et al. (2019) noted that attitudes toward math decline with grade level. More recently, Megreya et al. (2024) reported that about 20% of Qatari students experienced high math anxiety, with females more affected. Similar concerns were echoed in PISA 2022, which highlighted test-related anxiety as a global issue, particularly among low performers and high-achieving girls.

The Philippines' PISA 2022 results are especially concerning: the country ranked 77th of 81, with an average score of 355. Students with high anxiety scored about 60 points lower than their peers, often expressing fear and helplessness. Conversely, those with a growth mindset scored 18 points higher, while mathematics-specific grit was found to mediate the link between anxiety and performance (Yu et al., 2021).

Research highlights the importance of instructional materials and engagement in addressing these issues. Studies (Padernos, 2024) confirm that well-designed, contextually relevant materials enhance achievement, though effectiveness depends on integration into pedagogy. Engagement, encompassing behavioral, cognitive, emotional, and social dimensions, also strongly predicts performance (Reeve et al., 2025).

Guided by these insights, the present study develops an instructional framework that integrates PISA-type tasks and localized materials to reduce anxiety and strengthen engagement among Grade 9 students at Iligan City East National High School. The goal is to improve mathematical understanding, resilience, and 21st-century skills, offering a model that may inform broader educational practice.

2. METHOD

This study employed a convergent mixed-methods design to examine the relationship between mathematics anxiety, student engagement, and mathematics performance, and to develop an instructional framework for Grade 9 students. This design enabled the integration and triangulation of quantitative and qualitative data, providing a more comprehensive understanding of these complex issues (Creswell & Plano Clark, 2018).

The quantitative strand assessed changes in anxiety, engagement, and performance before and after the intervention. A 4-point Likert survey measured students' mathematics anxiety and engagement across social, cognitive, and emotional domains. A 10-item PISA-based test focused on perimeter and area of polygons (OECD, 2019). Data were analyzed using descriptive statistics and paired t-tests to evaluate performance and attitudinal shifts (Fraenkel et al., 2019).

The qualitative strand explored students' experiences and affective factors through journals, embedded interviews, and structured classroom observations. These data provided insights into emotional responses, peer interactions, and collaborative practices. Content analysis was used to code and synthesize themes, while triangulation enhanced trustworthiness (Cohen et al., 2018).

Findings from both strands were integrated through side-by-side comparisons and joint displays, identifying points of convergence and divergence. This approach captured the multifaceted nature of student engagement. It provided the foundation for an instructional framework aimed at reducing anxiety, enhancing engagement, and improving problem-solving skills through real-world, PISA-type tasks.

3. RESULTS AND DISCUSSION

Mathematics anxiety is a psychological condition that hinders students' engagement and performance in math. It reduces interest, lowers achievement, and often leads to avoidance of math-related tasks, creating gaps in foundational skills. This cycle can persist from elementary school into adulthood, influencing career choices and everyday confidence with numbers. Addressing math anxiety requires early intervention through supportive learning environments, growth mindset promotion, and the integration of anxiety-reduction strategies in instruction. Table 1 presents the students' level of mathematics anxiety as measured by five specific indicators, both before and after the intervention.

Table 1
Students' Mathematics Anxiety Level per Indicator Before and After Intervention

Table 1
Students' Mathematics Anxiety Level per Indicator Before and After Intervention

STATEMENTS	PRE			POST		
	MEAN	*SD*	QUALITATIVE DESCRIPTION	*MEAN*	*SD*	QUALITATIVE DESCRIPTION
1. I often worry that it will be difficult for me in mathematics classes.	2.95	0.75	Moderate Anxiety	2.97	0.69	Moderate Anxiety
2. I feel very anxious, even if I am well prepared for a test	3.08	0.56	Moderate Anxiety	2.97	0.66	Moderate Anxiety
3. I get very tense when I study for a test in mathematics.	2.55	0.70	Moderate Anxiety	2.47	0.75	Low Anxiety
4. I get nervous when I do not know how to solve a mathematics problem.	3.18	3.30	Moderate Anxiety	3.23	0.61	Moderate Anxiety
5. I worry I will get poor grades in mathematics.	3.30	0.90	Moderate Anxiety	3.48	0.63	Moderate Anxiety

The table shows that students' math anxiety mostly remained at a moderate level after the intervention, with one indicator dropping from moderate to low, suggesting some positive impact. However, anxiety about grades slightly increased, indicating that performance pressure persists. Overall, the intervention stabilized anxiety levels but highlighted the need for sustained, multifaceted strategies to achieve greater reductions.

To summarize in Table 2, the students' pre-intervention scores indicated a moderate level of mathematics anxiety, with a mean score of 3.01 and a standard deviation of 1.24. Following the intervention, the mean score showed a slight, non-significant increase to 3.02, while the standard deviation decreased to 0.67. Although the change in the mean was minimal, the reduction in standard deviation suggests that students' responses became more consistent. This indicates that, after the intervention, students' levels of mathematics anxiety were more closely clustered around the mean, reflecting a greater uniformity in their experiences.

Table 2
Summary of Students' Level of Mathematics Anxiety

	N	*Minimum*	*Maximum*	*Mean*	*SD*	*Category*
Pretest	86	1.2	3.8	3.01	1.24	Moderate Anxiety
Posttest	86	1.6	4.0	3.02	0.67	Moderate Anxiety

Table 3 shows a negligible change in students' math anxiety, with mean scores rising slightly from 3.01 to 3.02. The *t-value* (-0.0140) and p-value (0.8255) indicate no statistically significant difference, suggesting the intervention did not meaningfully affect anxiety levels.

Table 3
Analysis of the Change in the Mathematics Anxiety Levels

	Mean	*DIFF*	*SD*	*SE*	*t*	*p-value*	
Pretest	3.01	-0.0140	0.5851	0.0631	00.22	.8255	Not Significant
Posttest	3.02						

*significant at $p < .05$

The findings indicate that the intervention had little effect on reducing math anxiety, contrasting with Sammallahti et al.'s (2023) meta-analysis, which reported moderate reductions when interventions were more prolonged and more intensive. The short duration of this study may have limited its impact, aligning more closely with Tunç-Pekkan et al. (2023), who also found no significant change in anxiety after an eight-week program.

Levels of Students' Mathematics Learning Engagement

Student engagement in mathematics involves social, emotional, and cognitive dimensions, which are necessary to improve students' academic performance. This highlights the need for strategies that foster higher-order thinking and sustained effort. The following sections present students' levels of engagement across these dimensions.

***Levels of** Students' Social Learning Engagement.* Social engagement in mathematics involves students' interactions with peers, teachers, and the classroom community through collaboration, communication, and group activities. It fosters deeper understanding, positive attitudes, and a sense of belonging, while also developing interpersonal and problem-solving skills. Teachers can promote social engagement by encouraging group work, peer tutoring, and collaborative problem-solving, which help reduce anxiety, increase motivation, and enhance both learning and social-emotional competencies.

Table 4 presents the students' level of social engagement as measured by four specific indicators, both before and after the intervention. Table 4 shows that social engagement levels remained in the same category after the intervention, but mean scores declined slightly across all statements. Standard deviations also decreased, indicating more consistent responses. Overall, the intervention did not enhance social engagement, suggesting a need for more collaborative and group-based activities in future implementations.

Table 4
Students' Level of Social Engagement per Indicator Before and After Intervention

	STATEMENTS	PRE			POST		
		MEAN	*SD*	QUALITATIVE DESCRIPTION	*MEAN*	*SD*	QUALITATIVE DESCRIPTION
SOCIAL ENGAGEMENT	1. Today I talked about math with other classmates in class.	3.36	0.66	Moderate Social Engagement	3.08	0.65	Moderate Social Engagement
	2. Today, I helped other classmates with math when they didn't know what to do.	3.05	0.70	Moderate Social Engagement	2.86	0.64	Moderate Social Engagement
	3. Today, I shared ideas and materials with other classmates in math class.	3.08	0.67	Moderate Social Engagement	2.83	0.60	Moderate Social Engagement
	4. Students in my math class helped each other learn today.	3.24	0.65	Moderate Social Engagement	3.12	0.64	Moderate Social Engagement

To summarize, Table 5 shows that students' social engagement remained moderate, with the mean dropping from 3.18 to 2.97. The lower standard deviation suggests more consistent responses after the intervention, indicating a more uniform level of engagement.

Table 5
Summary of Students' Level of Social Engagement

	N	*Minimum*	*Maximum*	*Mean*	*SD*	*Category*
Pretest	86	1.25	4.00	3.18	0.67	Moderate Social Engagement
Posttest	86	2.00	4.00	2.97	0.63	Moderate Social Engagement

Table 6 shows a significant decline in social engagement, with mean scores dropping from 3.18 to 2.97 (p = 0.0075). This suggests the intervention reduced social interaction, possibly as students focused more on cognitive engagement and independent problem-solving.

Table 6
Analysis of the Change in the Social Engagement Levels

	Mean	*DIFF*	*SD*	*SE*	*t*	*p-value*	
Pretest	3.18	0.2006	0.6793	0.0733	2.74	.0075	Significant
Posttest	2.97						

*significant at $p < .05$

Unlike Martin and Rimm-Kaufman (2015), who found low-confidence students avoided collaboration, the decline here may reflect a shift toward cognitive rather than social engagement. The intervention's structured, reflective tasks may have encouraged quieter, independent learning, suggesting that meaningful engagement can take multiple forms.

Levels of *Students' Emotional Learning Engagement.* Emotional engagement in mathematics involves students' feelings, attitudes, and motivation toward learning. Positive emotions like interest and enjoyment foster persistence and participation, while negative emotions such as fear or frustration hinder learning. Teachers play a key role by creating supportive environments that encourage confidence and risk-taking. Table 7 presents the students' level of emotional engagement as measured by five specific indicators, both before and after the intervention. Results show that overall emotional engagement remained moderate, though slight increases in statements 5, 6, and 8 suggest modest gains in interest, enjoyment, and perceived value. These minor improvements indicate the intervention fostered some positive responses, but more targeted strategies are needed to strengthen emotional engagement.

Table 7
Students' Level of Emotional Engagement per Indicator Before and After Intervention

	STATEMENTS	PRE			POST		
		MEAN	*SD*	QUALITATIVE DESCRIPTION	*MEAN*	*SD*	QUALITATIVE DESCRIPTION
EMOTIONAL ENGAGEMENT	5. Math class was fun today.	3.14	0.70	Moderate Emotional Engagement	3.30	0.60	Moderate Emotional Engagement
	6. Today I felt bored in math class.	3.13	0.81	Moderate Emotional Engagement	3.26	0.64	Moderate Emotional Engagement
	7. I enjoyed thinking about math today.	2.97	1.22	Moderate Emotional Engagement	2.95	0.70	Moderate Emotional Engagement
	8. Learning math was interesting to me today.	3.35	0.65	Moderate Emotional Engagement	3.38	0.64	Moderate Emotional Engagement
	9. I liked the feeling of solving problems in math today.	3.21	0.75	Moderate Emotional Engagement	3.07	0.72	Moderate Emotional Engagement

To summarize, Table 8 shows a slight rise in mean emotional engagement (3.16 to 3.19) and reduced variability, indicating more consistent responses. However, overall engagement remained at a moderate level, suggesting the intervention had little effect.

Table 8
Summary of Students' Level of Emotional Engagement

	N	*Minimum*	*Maximum*	*Mean*	*SD*	*Category*
Pretest	86	2.00	4.00	3.16	0.83	Moderate Emotional Engagement
Posttest	86	2.00	4.00	3.19	0.66	Moderate Emotional Engagement

Table 9 shows a slight rise in emotional engagement (3.16 to 3.19), but the difference was not statistically significant (p = 0.4964), indicating the intervention did not meaningfully enhance students' emotional engagement.

Table 9
Analysis of the Change in the Emotional Engagement Levels

	Mean	*DIFF*	*SD*	*SE*	*t*	*p-value*	
Pretest	3.16	-0.0465	0.6315	0.0681	-0.68	.4964	Not significant
Posttest	3.19						

**significant at p < .05*

Unlike Martin and Rimm-Kaufman (2015), who achieved gains through targeted practices, this study aligns with Shenkut et al. (2022), showing no significant improvement in emotional engagement. These findings suggest that fostering emotional connection requires more student-centered, emotionally responsive strategies.

Levels of *Students' Cognitive Learning Engagement.* Cognitive engagement in mathematics involves students' effort to understand concepts, solve problems, and apply critical thinking. It goes beyond memorization, requiring persistence, reflection, and flexible problem-solving. This deep approach fosters meaningful understanding, transfer of knowledge, and long-term success. Teachers can promote it through inquiry-based lessons, reasoning tasks, and collaborative problem-solving.

Table 10 presents the students' level of emotional engagement as measured by three specific indicators, both before and after the intervention. Table 10 shows that students' cognitive engagement remained largely consistent across all indicators. Minor increases were observed in Statements 10 and 12, while slight decreases appeared in Statements 11 and 13, though qualitative levels stayed the same. Reduced standard deviations suggest more consistent responses, indicating the intervention sustained, but did not substantially improve cognitive engagement.

Table 10
Students' Level of Cognitive Engagement per Indicator Before and After Intervention

	STATEMENTS	PRE			POST		
		MEAN	*SD*	QUALITATIVE DESCRIPTION	*MEAN*	*SD*	QUALITATIVE DESCRIPTION
COGNITIVE ENGAGEMENT	10. Today in Math class I worked as hard as I could.	3.47	0.72	Moderate Cognitive Engagement	3.50	0.65	Moderate Cognitive Engagement
	11. Today it was important to me that I understood math well.	3.60	1.09	High Cognitive Engagement	3.58	0.56	High Cognitive Engagement
	12. I tried to learn as much as I could in math class today.	3.52	0.67	High Cognitive Engagement	3.58	0.54	High Cognitive Engagement
	13. I did a lot of thinking in math class today.	3.25	0.67	Moderate Cognitive Engagement	3.21	0.63	Moderate Cognitive Engagement

Table 11 shows a slight increase in mean cognitive engagement from 3.46 to 3.47, with reduced variability in scores. However, since both means fall within the "Moderate" range, the change is minimal and not significant. Minimal change in cognitive engagement may be due to the time needed for deeper skills to develop, as critical thinking and sustained effort require extended exposure. Factors such as task difficulty, prior knowledge, or pacing may also have influenced outcomes.

Table 11
Summary of Students' Level of Cognitive Engagement

	N	*Minimum*	*Maximum*	*Mean*	*SD*	*Category*
Pretest	86	1.50	4.00	3.46	0.79	Moderate Cognitive Engagement
Posttest	86	2.50	4.00	3.47	0.60	Moderate Cognitive Engagement

As shown in Table 12, the mean score rose only slightly from 3.46 to 3.47, with a t-value of -0.16 and p-value of 0.8701, confirming no significant difference. This suggests the intervention had little impact on cognitive engagement.

Table 12
Analysis of the Change in the Cognitive Engagement Levels

	Mean	*DIFF*	*SD*	*SE*	*t*	*p-value*	
Pretest	3.46	-0.0116	0.6574	0.0709	-0.16	.8701	Not significant
Posttest	3.47						

**significant at $p < .05$*

Guerreiro (2017) found that technology-enhanced math tasks can improve cognitive engagement when interactive and well-integrated, highlighting the importance of intervention design and implementation. The minimal impact observed in this study may stem from differences in design, duration, or delivery. Similarly, Jaeggi et al. (2023) reported that a supplemental metacognitive program did not significantly enhance cognitive outcomes beyond working memory training, suggesting that not all interventions yield substantial gains. These comparisons stress the need for carefully designed approaches to foster meaningful cognitive engagement.

Factors that Cause Mathematics Anxiety

Findings from the present study reveal several factors contributing to mathematics anxiety among participants. These include: (1) the nature of mathematics as a subject, (2) students' negative perceptions toward mathematics, (3) the teacher's attitude and instructional style, (4) fear of peer criticism, (5) lack of self-confidence, and (6) parental pressure.

Math as a Subject. Many students reported difficulty in grasping concepts despite repeated explanations, which left them discouraged and demotivated. This aligns with Gafoor and Kurukkan (2015), who noted that mathematics is often disliked for its inherent difficulty and teaching practices that overlook diverse needs.

Negative Perceptions. Feelings of fear, hesitation, and "what ifs" reflected a belief of being "bad at math." Prior studies (Hagan et al., 2020) confirm that attitudes often deteriorate as difficulties accumulate, fueling disengagement.

Teacher's Style. Strict or unclear instructions, rapid pacing, and lack of support heightened anxiety. Salter and Wuthrich (2024) similarly found that unsympathetic or rigid teaching fosters academic anxiety.

Peer Criticism and Confidence. Fear of ridicule discouraged students from answering, reinforcing feelings of inadequacy. This reflects the role of peer dynamics in shaping anxiety and confidence.

Parental Pressure. High expectations and comparisons further intensified stress (Yin et al., 2024).

Overall, the findings reveal that mathematics anxiety arises from intertwined academic, social, and emotional factors. These insights highlight the importance of designing instructional materials that not only address cognitive demands but also reduce anxiety, foster confidence, and create supportive learning environments—principles central to the proposed instructional framework.

Factors that Cause Mathematics Engagement

Students' engagement in the classroom is essential for shaping how they approach mathematics and for building confidence in their abilities. When students develop genuine interest, mathematics becomes meaningful rather than a chore, leading to deeper understanding, problem-solving, and long-term success. Engagement fosters persistence, resilience, and collaboration, while also nurturing curiosity and critical thinking that connect classroom concepts to real-world applications. The key factors contributing to mathematics engagement are: (1) the teacher's positive disposition, (2) peer support, (3) a positive attitude toward mathematics, and (4) goal-driven learning.

Teacher's Positive Disposition (Emotional Engagement). Teachers play a central role in building engagement through clarity, warmth, and responsiveness. McKay and Macomber (2023) noted that supportive teachers reduce anxiety and encourage participation. Students in this study valued approachable teachers who explained clearly and provided guidance, affirming Liu's (2024) finding that teacher support fosters confidence, resilience, and emotional safety.

Peer Support (Social Engagement). Collaboration with classmates strengthens comprehension and reduces anxiety. Nearly half of the students reported relying on peers to clarify lessons, showing the importance of social support. Jojo (2022) similarly found that peer mentoring and discussions enhance problem-solving, enjoyment, and accountability, making mathematics less intimidating.

Positive Attitude (Emotional Engagement). Emotional disposition strongly influences success. Students who found math interesting and enjoyable persisted longer and engaged more deeply, consistent with Huda and Syafmen (2021). Conversely, anxiety and frustration led to disengagement. A favorable classroom climate that celebrates growth fosters enthusiasm and resilience.

Goal-Driven (Cognitive Engagement). Curiosity and a sense of purpose motivated learners to persist in problem-solving, echoing Kaleva et al. (2019). Such engagement promotes self-regulation and more profound understanding, especially when linked to real-life contexts.

Together, these findings highlight the interplay of emotional, social, and cognitive engagement in sustaining meaningful learning in mathematics.

Students' Performance on the 10-item PISA Questions

The analysis of the students' change in performance levels on the 10-item PISA-type questions is presented in Table 13. This table highlights the shift in students' abilities to tackle the PISA-style problems before and after the instructional intervention.

Table 13
Analysis of the Change in Mathematics Performance

	Mean	*DIFF*	*SD*	*SE*	*t*	*p-value*	
Pretest	44.461	-20.926	14.6940	1.5845	-13.23	Less than .001	Highly Significant
Posttest	65.930						

***highly significant at p < .001*

The results indicate a significant improvement in students' performance on PISA-type questions following the instructional intervention. The mean increase of 20.97 points demonstrates notable gains in understanding and problem-solving skills. Statistical analysis confirms this effect, with a t-value of -13.23 and a p-value below 0.001, indicating the improvement is highly significant. While the standard deviation of 14.69 suggests some variation among students, the small standard error of 1.58 shows the mean is a reliable estimate of the population. Overall, the findings confirm that the instructional materials and activities effectively enhanced students' mathematical proficiency, engagement, and confidence in solving complex problems.

Process of the Development of Instructional Materials

Instructional materials play a vital role in making learning engaging and meaningful. As Purwitaningrum and Prahmana (2021) note, these are essential—not just supplementary—in clarifying concepts and sustaining student interest. In this study, materials were developed through Stanford's five design thinking phases: empathize, define, ideate, prototype, and test (Henriksen et al., 2017).

In the empathize phase, student and teacher interviews revealed math anxiety, weak foundational skills, and low confidence. To address these, the define and ideate phases emphasized building from simple, familiar problems toward more complex ones, helping students gain early success and confidence (Anaya et al., 2022). The prototype phase involved iterative revisions, integrating real-world and PISA-type tasks to strengthen skills and engagement. Finally, the test phase collected student and teacher feedback, refining materials for clarity, pacing, and inclusivity.

Through this process, the instructional materials became learner-centered, gradually reducing anxiety while fostering confidence, curiosity, and persistence in mathematics. By embedding empathy and iteration, the design ensured that learning was both meaningful and supportive.

Instructional Framework in Promoting Learning Engagement in the Mathematics Classroom

This section presents the proposed instructional framework to promote mathematics engagement, grounded in Freud's theory of anxiety in learning, principles of contextual knowledge, and student engagement models. Informed by both qualitative and quantitative findings, the framework adopts the Kelley Design Thinking Model—empathize, define, ideate, prototype, and test—to prioritize learners' needs and foster deeper engagement.

Instructional materials were developed through interviews, assessments, and expert reviews to target learning gaps, reduce anxiety, and enhance participation. Contextualized, real-life tasks made mathematics more meaningful and built student confidence through incremental successes. Student feedback highlighted positive indicators such as motivation, focus, and collaboration, while also guiding revisions to improve clarity and relevance.

Recognizing the influence of prior experiences, environment, and knowledge, the framework emphasizes supportive classroom environments that reframe mathematics as a subject of opportunity. At its core, the PIERR cycle—Plan, Implement, Evaluate, Reflect, Refine—ensures continuous improvement of materials and practices, promoting sustained cognitive, emotional, and social engagement in mathematics.

Figure 1

PIERR: Instructional Framework in Promoting Mathematics Engagement

Students bring prior experiences, environments, and knowledge into the classroom, which shape how they view new learning. In mathematics, many develop anxiety or negative attitudes, making it essential for teachers to foster supportive and engaging experiences that build confidence. The proposed instructional framework, represented by the PIERR cycle—Plan, Implement, Evaluate, Reflect, Refine—provides a structured, iterative approach. Materials are carefully designed to align with student needs, tested in real classrooms, and evaluated through output and feedback. Reflections guide revisions, ensuring continuous improvement. By integrating theory, practice, and iterative design, this framework helps shift perceptions of mathematics and promotes deeper engagement, stronger problem-solving, and improved performance.

4. CONCLUSION

This study examined the effectiveness of a designed instructional framework in promoting mathematics engagement and addressing anxiety among Grade 9 students. While math anxiety showed a slight, non-significant increase, qualitative findings revealed persistent emotional barriers—such as perceived difficulty, fear of peer judgment, negative self-perception, and external pressures—indicating that addressing anxiety requires sustained, multi-faceted support. Social engagement declined, reflecting a shift from peer collaboration to teacher-guided learning, highlighting the need to balance structured guidance with opportunities for peer interaction. Cognitive and emotional engagement showed modest gains, with students demonstrating improved focus, persistence, and curiosity during problem-solving tasks. Students' performance on PISA-type questions also improved significantly, with a mean increase of 20.969 points ($p < 0.001$), showing that the intervention enhanced understanding and higher-order thinking. The framework followed a cyclical PIERR process—Plan, Implement, Evaluate, Reflect, Refine—allowing continuous improvement of materials based on classroom experience, student feedback, and teacher observations.

Therefore, it is recommended to implement sustained interventions to reduce math anxiety; promote structured peer collaboration; continue refining materials via PIERR; strengthen cognitive and emotional engagement through active learning and real-life applications; provide teacher training on engagement strategies; expand performance-based assessments; and conduct longitudinal research to evaluate long-term effects across contexts.

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REFERENCES

Anaya, L., Iriberri, N., Rey-Biel, P., & Zamarro, G. (2022). Understanding performance in test taking: The role of question difficulty order. *Economics of Education Review, 90*, 102293.

Cohen, L., Manion, L., & Morrison, K. (2018). Research methods in education (8th ed.). Routledge.

Creswell, J. W., & Plano Clark, V. L. (2018). Designing and conducting mixed methods research (3rd ed.). SAGE.

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2019). How to design and evaluate research in education (10th ed.). McGraw-Hill.

Gafoor, K. A., & Kurukkan, A. (2015). Why High School Students Feel Mathematics Difficult? An Exploration of Affective Beliefs. *Online submission*.

Guerreiro, M. (2017). *The impact of a technology-enhanced math performance task on student cognitive engagement in mathematics* (Doctoral dissertation, University of Oregon).

Hagan, J. E., Amoaddai, S., Lawer, V. T., & Atteh, E. (2020). Students' perception towards mathematics and its effects on academic performance. *Asian Journal of Education and Social Studies*, *8*(1), 8-14.

Henriksen, D., Richardson, C., & Mehta, R. (2017). Design thinking: A creative approach to educational problems of practice. *Thinking skills and Creativity*, *26*, 140-153.

Huda, N., & Syafmen, W. (2021). The Relationship between Students' Mathematical Disposition and Their Learning Outcomes. *Journal of Education and Learning (EduLearn)*, *15*(3), 376-382.

Jaeggi, S. M., Weaver, A. N., Carbone, E., Trane, F. E., Smith-Peirce, R. N., Buschkuehl, M., ... & Borella, E. (2023). EngAge–A metacognitive intervention to supplement working memory training: A feasibility study in older adults. *Aging Brain*, *4*, 100083.

Jojo, Z. (2022). Engaging mathematics student-teachers in an Open Distance e-Learning context. Perspectives in Education, 40(1), 196-211.

Kaleva, S., Pursiainen, J., Hakola, M., Rusanen, J., & Muukkonen, H. (2019). Students' reasons for STEM choices and the relationship of mathematics choice to university admission. *International Journal of STEM Education*, *6*, 1-12.

Liu, X. (2024). Effect of teacher–student relationship on academic engagement: the mediating roles of perceived social support and academic pressure. *Frontiers in Psychology*, *15*, 1331667.

Martin, D. P., & Rimm-Kaufman, S. E. (2015). Do student self-efficacy and teacher-student interaction quality contribute to emotional and social engagement in fifth grade math?. *Journal of school psychology*, *53*(5), 359-373

Mazana, Y. M., Suero Montero, C., & Olifage, C. R. (2019). Investigating students' attitude towards learning mathematics.

McKay, C., & Macomber, G. (2023). The importance of relationships in education: Reflections of current educators. *Journal of Education*, *203*(4), 751-758.

Megreya, A. M., Al-Emadi, A. A., Al-Ahmadi, A. M., Moustafa, A. A., & Szűcs, D. (2024). A large-scale study on the prevalence of math anxiety in Qatar. *British Journal of Educational Psychology*, *94*(2), 539-556.

OECD. (2019). PISA 2018 results (Volume I): What students know and can do. OECD Publishing.

Padernos, J. L. F. (2024). Utilization of Teacher-Made Learning Activity Sheets as a Tool in Improving Learners' Numeracy Skills: An Action Research. *International Journal of Multidisciplinary: Applied Business and Education Research*, *5*(4), 1222-1227.

Purwitaningrum, R., & Prahmana, R. C. I. (2021). Developing instructional materials on mathematics logical thinking through the Indonesian realistic mathematics education approach. *International Journal of Education and Learning*, *3*(1), 13-19.

Reeve, J., Basarkod, G., Jang, H. R., Gargurevich, R., Jang, H., & Cheon, S. H. (2025). Specialized Purpose of Each Type of Student Engagement: A Meta-Analysis. *Educational Psychology Review*, *37*(1), 1-38.

Sammallahti, E., Finell, J., Jonsson, B., & Korhonen, J. (2023). A meta-analysis of math anxiety interventions. *Journal of Numerical Cognition*, *9*(2), 346-362.

Shenkut, H. A. B. T. A. M. U., Atnafu, M. U. L. U. G. E. T. A., & Michael, K. (2022). The Effect of Blended Learning Approach on Students' Engagement in Learning Algebra. *Staff and Educational Development International*, *25*(1), 183-198.

Tunç-Pekkan, Z., Ölmez, İ. B., & Taylan, R. D. (2023). An Online Laboratory School research on pre-service mathematics teachers' experiences and mathematics teaching anxiety. *Education and Information Technologies*, *28*(5), 5739-5761.

Uniyal, A. K., & Bhardwaj, M. M. (2021). Anxiety and Self Concept towards Mathematics amongst the University Students of North India with Reference to Uttarakhand and Uttar Pradesh. *Webology*, *18*(1).

Yin, X., Zhang, H., & Chen, M. (2024). The influence of parents' education anxiety on children's learning anxiety: the mediating role of parenting style and the moderating effect of extracurricular tutoring. *Frontiers in Psychology*, *15*, 1380363.

Yu, Y., Hua, L., Feng, X., Wang, Y., Yu, Z., Zi, T., ... & Li, J. (2021). True grit in learning math: The math anxiety-achievement link is mediated by math-specific grit. *Frontiers in Psychology*, *12*, 645793.