SENSING MATH ANXIETY: HOW EMOTIONAL SKILLS SHAPE CHILDREN'S ABILITY TO MAKE SENSE OF MATHEMATICS

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Math anxiety, linked to avoidance of numerical tasks and problem solving, remains under-researched in Mexican primary education. This study examines math anxiety and its emotional dimension in third- and fourth-grade students using a mixed-methods design with 1,300 students from 11 schools. Associations between math anxiety, emotional skills, and math *performance were analysed. Results show strong negative relationships between emotional skills and math anxiety, and between math anxiety and performance. Students with lower perceived self-efficacy and more negative beliefs reported higher anxiety and lower achievement. High math anxiety was observed among high-performing students, suggesting future avoidance. The findings highlight the importance of the emotional dimension of math anxiety in early education.*

INTRODUCTION

For many individuals, learning mathematics generates tension that leads to avoidance of numerical tasks and mathematical problem solving, thereby limiting academic development and everyday quantitative reasoning. These reactions are commonly associated with math anxiety, defined as a feeling of tension that interferes with numerical manipulation and problem solving in academic and everyday contexts (Richardson & Suinn, 1972). It is a multifactorial construct whose complexity is not yet fully understood, but empirical evidence consistently links it to lower academic performance (Ashcraft & Moore, 2009) and shows that its early emergence negatively affects both mathematical learning and children's broader school experience (Rossnan, 2006). Although it can manifest even in simple numerical tasks, it tends to become more pronounced in activities that place higher demands on working memory, such as operations involving carrying or borrowing or working with mixed fractions (Ashcraft & Kirk, 2001).

Research has largely focused on adults, teachers, and university students, yet growing evidence shows that math anxiety can emerge in early primary school, sometimes from age six. Anxiety responses to simple numerical tasks observed in adults suggest that its origins may lie in the acquisition of basic number knowledge rather than later exposure to advanced mathematics (Maloney et al., 2015).

The early development of math anxiety is associated with reduced motivation and increased avoidance of quantitative activities. Its consequences extend beyond schooling, limiting participation in STEM fields and access to mathematically demanding careers (Ashcraft & Moore, 2009). In the twenty-first century, these effects

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are particularly consequential, as quantitative reasoning is essential for technological innovation and economic competitiveness, with stronger math skills linked to long-term economic growth (Dowker et al., 2019; OECD, 2010).

In Mexico, these issues are clearly apparent. The country performs below the OECD average in mathematics, with international and national assessments revealing substantial learning gaps from early, and over 75% of students report feeling anxious about mathematics (OECD, 2010). However, math anxiety is shaped by cultural and educational contexts and does not emerge uniformly across mathematical topics, as anxiety is not necessarily associated with the same concepts in different school systems (Lau et al., 2022). As most existing evidence derives from Western, Educated, Industrialised, Rich, and Democratic countries (WEIRD), it remains unclear whether these patterns apply to the Mexican context, underscoring the need to explore this construct in math learning.

THEORETICAL FRAMEWORK

Math anxiety comprises interrelated cognitive and emotional dimensions. The cognitive dimension involves executive functions, particularly working memory and attentional control, which are taxed during mathematically demanding tasks (Ashcraft & Krause, 2007), whereas the emotional dimension includes socio-emotional skills such as self-regulation and perceived self-efficacy, closely linked to motivation. The interaction between these dimensions affects mathematics performance and may generate a cyclical pattern in which repeated failure increases anxiety and further undermines achievement. This process is explained by Pekrun's Control–Value Theory, which posits that achievement emotions arise from appraisals of perceived control and task value (Pekrun et al., 2007), with math anxiety more likely when perceived control is low and task value is high, underscoring the central role of self-efficacy (Bandura, 1993).

Within this framework, examining math anxiety in the early school years is particularly relevant, as it informs the design of early interventions and clarifies its association with academic performance. Emotions, beliefs, and perceptions of control related to mathematics are also shaped by cultural and educational contexts, influencing how students experience and respond to mathematical learning.

Accordingly, this study focuses on third- and fourth-grade primary school students, a critical stage in the acquisition of foundational mathematical concepts. Difficulties encountered during this period may be closely associated with the emergence of math anxiety, particularly as cognitive demands increase and early learning experiences begin to shape students' beliefs and emotional responses to mathematics (Dowker et al., 2019). The study examines the question of how specific emotional skills influence the relationship between math anxiety and math performance in primary students.

METHODS

Following a mixed-methods framework, this study employed a non-experimental, sequential exploratory design. The qualitative phase preceded the quantitative phase and informed instrument refinement. The research involved 1,313 third- and fourth-grade students (52% girls, 48% boys; *M* age = 8.8 years, *SD* = 0.68) from 11 Mexican schools across different regions (10 private, 1 public). Parental consent was required. Teachers administered the instruments, which were completed online under school-based supervision.

*Qualitative phase***.** An online questionnaire collected information on students' experiences with mathematics, including their liking of the subject, perceived difficulty of topics or concepts, emotions during lessons or homework, and physical sensations associated with mathematics activities (e.g., stomachaches, headaches). Consistent with an exploratory sequential mixed-methods design, findings from this phase informed the development of the quantitative instruments by guiding the construction of the math test and the operationalisation of students' perceptions into measurable indicators of math anxiety, emotional skills, and performance.

Quantitative phase. The constructs under study were assessed using validated instruments. Perceived self-efficacy was measured with the Self-Efficacy for Self-Regulated Learning Scale (Zimmerman et al., 1992), beliefs and expectations about mathematical competence with the questionnaire by Wigfield and Eccles (2000), intrinsic motivation with the Spanish adaptation of the Academic Self-Regulation Questionnaire (Conesa & Duñabeitia, 2022), and emotional intelligence with the Brief Emotional Intelligence Scale (Davies et al., 2010). Mathematics anxiety was assessed using the SEMA Scale (Wu et al., 2012), while general anxiety was included as a control variable (Gillis, 2003). Math performance was evaluated using 10 items adapted from a national test (SEP, 2013). All instruments used a 1–5 Likert scale with emojis and were refined through a pilot study conducted prior to the main data collection. Students completed the online questionnaires and mathematics test individually, in approximately 35–40 minutes and 20 minutes, respectively. Qualitative responses were analysed using open and axial coding, and quantitative data were examined using descriptive and inferential analyses in Jamovi (Version 2.4.8).

RESULTS

Qualitative responses provided insight into how students experience mathematics in everyday classroom contexts. Students reported a range of emotions, preferences, and perceived difficulties that helped characterise the affective dimensions associated with math anxiety. Students described both positive emotions (e.g., happiness, enthusiasm, feeling challenged) and negative emotions (e.g., boredom, frustration, nervousness, anger). Negative emotions were mainly associated with examinations, unfamiliar content, time pressure, and tasks requiring rapid calculation. Overall, most students expressed a positive disposition towards mathematics, particularly for familiar and

foundational content such as addition, where they reported feeling confident. In contrast, more complex topics—including division, area and perimeter, decimals, and especially word problems—were frequently identified as difficult. Difficulties with converting between fractions and decimals were also commonly reported.

Quantitative analyses complemented these first insights measuring emotional skills, math anxiety, and math performance. Students who exceeded the general anxiety cut-off score were excluded, resulting in a final sample of n = 1,212. Descriptive analyses showed that students reported high levels of emotional skills, with mean scores of 4.03 for perceived self-efficacy, 4.10 for beliefs and expectations, 4.05 for intrinsic motivation, and 4.24 for emotional intelligence. In contrast, mean math anxiety was low (M = 1.87, SD = 0.71). All instruments demonstrated good to excellent internal consistency, with Cronbach's alpha values ranging from 0.776 (emotional intelligence) to 0.921 (math anxiety), indicating adequate reliability across all measures. Regarding math performance, the mean math test score was 5.85 out of 10, with third-grade students scoring slightly lower (M = 5.69, SD = 2.12) than fourth-grade students (M = 6.04, SD = 1.99). Analysis of math test responses identified clear error patterns that aligned with students' self-reported difficulties: third-grade errors were most frequent in multiplication, perimeter, and decimal addition, whereas fourth-grade errors were most prevalent in fractions and division.

Building on these findings, Spearman correlation analyses were conducted to examine the associations among emotional skills, math anxiety, and math performance (Table 1). Emotional skills were positively correlated, while math anxiety showed negative associations with all emotional skills. Math performance was positively related to emotional skills and negatively related to math anxiety, indicating a consistent pattern of relationships among these variables.

Table 1. Spearman´s Correlations of Math Anxiety and Emotional Skills

Variables	**Beliefs & expectations**	**Self – efficacy**	**Intrinsic motivation**	**Emotional intelligence**	**Math anxiety**	**Math performance**
Beliefs & expectations	---	---	---	---	---	---
Self–efficacy	0.804***	---	---	---	---	---
Intrinsic motivation	0.594***	0.669***	---	---	---	---
Emotional intelligence	0.477***	0.534***	0.528***	---	---	---
Math anxiety	-0.391***	-0.424***	-0.268***	-0.258***	---	---
Math performance	0.191***	0.173***	0.084**	0.045	-0.350***	---

Finally, a math anxiety threshold was set at one standard deviation above the mean (51.61 points; Likert equivalent = 2.58). Using this criterion, 222 students (18% of the sample) were classified as having high math anxiety (Table 2).

Table 2. Mean Likert scores for emotional skills and math performance (n = 1212)

Variable	MA ≥ 2.58 (n = 222)	MA < 2.58 (n = 990)	p-value (t-test)	Overall (n = 1212)
Beliefs and Expectations	3.80	4.13	2.20E−21***	4.13
Perceived Self-Efficacy	3.64	4.12	1.87E−24***	4.03
Intrinsic Motivation	3.81	4.11	2.76E−10***	4.05
Emotional Intelligence	4.07	4.28	5.46E−08***	4.24
Math Anxiety	3.06	1.60	3.19E-26***	1.87
Math Performance	4.77	6.10	1.36E−18***	5.85

Mean comparisons showed consistent differences between students with and without math anxiety. Students with high anxiety scored lower in all emotional skills, while reporting substantially higher anxiety levels. Math performance also differed: students with high anxiety obtained a failing mean score (M = 4.77), whereas those without anxiety achieved a passing mean score (M = 6.10). All group differences were statistically significant ($p < .001$). It is noteworthy that within the high math anxiety group (n = 222), approximately one third (31%, n = 68) obtained a mean math test score of 7.3 (SD = 1.1), which is higher than the mean score of the full sample (M = 5.85, SD = 2.06; N = 1,212). This finding shows that high levels of math anxiety can coexist with relatively strong math performance in a subset of students.

DISCUSSION

The present study examined math anxiety and its emotional correlates among Mexican primary students, providing empirical evidence on how emotions, learning experiences, and performance interact during the early years of mathematical learning. The mixed-methods design made it possible to connect students' subjective experiences with quantitative patterns, thereby clarifying how math anxiety manifests in classrooms and how it relates to emotional skills and achievement.

Qualitative findings showed that negative emotions were most often triggered by mathematically demanding content—such as fractions, division, word problems, and reasoning tasks—which place substantial demands on working memory. This aligns with evidence that increased cognitive load can intensify anxiety (Ashcraft & Krause, 2007). Students also reported anxiety in situations involving evaluation, time pressure, or unfamiliar content, and frequently described physiological symptoms, highlighting the multidimensional nature of math anxiety and its impact on engagement.

Quantitative analyses corroborated these patterns. Students with high math anxiety reported significantly lower levels of perceived self-efficacy, beliefs and expectations, intrinsic motivation, and emotional intelligence, alongside markedly lower mathematics performance. Approximately 18% of students met the threshold for high anxiety, a proportion comparable to that reported by Wu et al. (2012), suggesting that a notable minority of students experience elevated math anxiety from an early age. A

further insight emerges from the subset of students who showed high math anxiety alongside relatively strong mathematical performance. This pattern suggests an affective–cognitive dissociation, where anxiety reflects emotional distress rather than limited competence. Students in this "silent risk group" may remain unnoticed in everyday classroom practice because their achievement masks their emotional difficulty. Although causal interpretations are not warranted, this profile is educationally significant: persistent anxiety may gradually undermine students' confidence, participation, and willingness to engage with challenging tasks, increasing the likelihood of future avoidance of mathematics and, potentially, STEM-related pathways.

Correlation analyses further showed that math anxiety was negatively associated with emotional skills and mathematics performance, while emotional skills were positively related to achievement. Perceived self-efficacy displayed the strongest association with math anxiety, aligning with research emphasising its central role in emotional regulation and learning (Pajares & Graham, 1999). The association between beliefs and expectations and math anxiety is also consistent with Control–Value Theory, which explains anxiety as emerging when perceived control is low and task value is high (Pekrun, 2007). Taken together, these findings support the view that math anxiety is embedded within a broader emotional–motivational system rather than representing an isolated response to mathematical content (Ashcraft & Moore, 2009).

In the Mexican educational context, where math anxiety is not yet recognised in teacher preparation or national curricula, these results show that students' mathematical difficulties cannot be interpreted solely as gaps in content knowledge. Rather, they reflect interactions between cognitive demands and emotional skills, which shape how students perceive and manage mathematical challenges. Recognising math anxiety as an educational issue may help teachers reinterpret avoidance or low achievement not as lack of ability but as potential emotional distress.

Finally, the findings highlight the need for instructional practices that attend to both cognitive and emotional dimensions of mathematics learning. Classrooms that normalise mistakes, reduce excessive evaluative pressure, and provide structured support during high-load tasks may help mitigate anxiety. Identifying topics that commonly elicit discomfort, such as fractions and division, can inform targeted scaffolding. These insights can guide context-sensitive practices and strengthen teacher professional development, contributing to more emotional supportive mathematics instruction in Mexican primary schools.

LIMITATIONS

Despite its contribution, the findings should be interpreted with caution. Responses may have been influenced by social desirability and the limitations of self-report measures for younger children, and the non-probabilistic sample restricts generalisability.

CONCLUSIONS

Overall, the findings show that emotional skills are closely associated with math anxiety and mathematics performance among Mexican primary school students. By focusing on an underrepresented educational context, the study extends existing research on math anxiety and highlights the interplay between cognitive demands and socio-emotional processes in early mathematics learning. The results offer a more grounded understanding of how math anxiety manifests in primary education and how emotional factors shape students' engagement and performance. Making math anxiety visible may also help teachers reinterpret avoidance or low achievement as manifestations of emotional difficulty rather than lack of ability or effort.

From an educational perspective, the findings highlight the relevance of addressing math anxiety as part of everyday mathematics instruction rather than as an isolated issue. Greater awareness of the emotional dimensions of learning cam guide schools and educational systems support instructional practices and teacher professional development that support students' perceptions, confidence, and emotional regulation during mathematical activity. This is especially relevant within the national education programme, highlighting the need for empirical evidence to inform pedagogical practice and sustained teacher learning.

Ultimately, the findings show that strengthening students' emotional skills is fundamental to supporting how they make sense of mathematics in their daily learning.

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