Educenter: Scientific Journal of Education
Vol 4 No 3 2025
ISSN: 2827-8542 (Print) ISSN: 2827-7988 (Electronic)
Open Access: https://jurnal.arkainstitute.co.id/index.php/educenter/index

The impact of learning motivation on mathematics anxiety among 4th grade elementary school students in Indonesia

Miming Fadhilah[1 *], Riyadi[2], Sandra Bayu Kurniawan[3]
[1, 2,3]Universitas Sebelas Maret, Indonesia
mimingfadhilah81@student.uns.ac.id

Article Info

Article history:
Received August 28th 2025
Revised October 17th 2025
Accepted October 31st 2025

Keywords:
Classroom action research; Elementary school; Learning motivation; Mathematics anxiety; Self-determination theory

ABSTRACT

Affective factors such as math anxiety have become a global concern in elementary education, as they have the potential to hinder students' cognitive development and engagement in mathematics learning. In the context of public elementary schools in a semi-urban area of Sragen Regency, this study aimed to analyze the effect of learning motivation on mathematics anxiety in fourth-grade students. This study used a quantitative approach with a quasi-experimental pretest–posttest control group design, focusing on the comparison between the intervention group and the control group. A total of 95 students were selected through cluster random sampling. Data were collected using a learning motivation questionnaire based on Self-Determination Theory and a validated mathematics anxiety scale. The analysis showed that increasing learning motivation significantly reduced levels of mathematics anxiety. Moreover, linear regression indicated a strong negative relationship between the two variables, with learning motivation explaining most of the variance in anxiety. These findings confirm that strengthening intrinsic motivation plays a significant role in reducing students' emotional distress towards mathematics. Therefore, motivation-based pedagogical strategies are recommended as an effective approach to creating a more positive and adaptive learning experience in elementary schools.

INTRODUCTION

Learning mathematics at the elementary school level is a complex challenge for students worldwide. Reports from the Programme for International Student Assessment (PISA) and the OECD indicate that mathematics anxiety is a major affective factor that lowers students' academic performance, particularly in countries with low numeracy scores, including Indonesia (OECD, 2023). This phenomenon indicates that mathematics anxiety is not only an individual issue but also reflects systemic challenges in mathematics learning at the elementary level.

In the Indonesian context, various studies indicate that mathematics anxiety has become a significant barrier to learning. Students often experience symptoms such as fear of math problems, reluctance to ask questions, and avoidance of numerical tasks (Ramirez et al., 2018). Findings from several elementary schools indicate that the proportion of students with high levels of mathematics anxiety reaches over 70%, with a greater tendency among female students with negative self-concepts (Saraswati & Kusumaningrum, 2024). These school-level findings reflect a broader trend in Indonesian elementary education, where math anxiety consistently impacts student performance nationally. Theoretically, this phenomenon can be explained through the Cognitive Interference Model of Anxiety (Rodríguez-Menchón et al., 2021), which states that negative emotions such as anxiety interfere with working memory capacity and logical thinking processes. Furthermore, Self-Efficacy Theory (Bandura in Evangelopoulou, 2024) explains that low self-confidence in math abilities exacerbates perceptions of learning difficulties and increases anxiety. Consequently, persistent anxiety not only decreases academic performance but also reduces students' self-confidence, active participation, and persistence in learning math. In this context, important questions arise regarding factors that can help reduce this anxiety—one of which is learning motivation.

Low learning motivation is another factor that exacerbates math anxiety. Several studies in Indonesia indicate that a large proportion of elementary school students have low motivation to learn

math (Lestari et al., 2022). However, these findings tend to be presented descriptively without in-depth theoretical synthesis. Based on Self-Determination Theory and Expectancy-Value Theory, intrinsic motivation can increase students' sense of competence and autonomy, which in turn reduces anxiety in mathematics learning (Rodríguez et al., 2021). The lack of contextual and engaging learning approaches results in low emotional engagement in mathematics, which reinforces a negative cycle: low motivation increases anxiety, and high anxiety decreases motivation to learn. Thus, the relationship between these two variables is not coincidental but reflects a complex psychological interaction between internal drives and emotional responses to learning.

Although several studies have examined the factors influencing mathematics anxiety and learning motivation separately, a research gap remains in understanding the causal relationship between the two, particularly in fourth-grade elementary school students. Most previous studies have focused on descriptively measuring levels of anxiety or learning motivation without examining the psychological mechanisms that explain how motivation can act as a predictor of anxiety reduction. Conceptually, learning motivation functions to increase self-efficacy and perceived control over learning tasks, which, according to the Affective Filter Hypothesis (Mawansyah, 2024), can reduce emotional inhibition during the learning process. This theoretical and empirical gap indicates the need for experimental research that can more deeply explain the mechanisms of the relationship between motivation and math anxiety in the context of elementary school students in Indonesia.

The selection of fourth-grade students as research subjects was based on considerations of cognitive development according to Piaget's theory, where students at this stage begin to transition from the concrete operational phase to the formal operational phase (Persada, 2024). At this stage, they begin to encounter more abstract mathematical concepts such as fractions and complex number operations, which have the potential to trigger higher anxiety if not supported by adequate learning motivation. This study used a quasi-experimental approach by integrating a quantitative design and participant observation simultaneously to examine the effectiveness of strategies to increase learning motivation in am to reduce math anxiety. This study does not aim to develop a final intervention model, but rather focuses on initial empirical testing of the effectiveness of a motivational approach in a real classroom context. Theoretically, this study is expected to strengthen Self-Determination Theory by demonstrating how intrinsic and extrinsic motivation act as mediators in reducing math anxiety.

Based on this description, this study was designed to answer several main questions such as What is the level of motivation to learn mathematics in fourth-grade elementary school students before and after implementing motivation-enhancing strategies? What is the level of mathematics anxiety in fourth-grade elementary school students before and after implementing motivation-enhancing strategies? Is there a significant effect of learning motivation on fourth-grade elementary school students' math anxiety? And How significant is the contribution of learning motivation to reducing fourth-grade elementary school students' math anxiety?

The purpose of this study is to analyze changes in levels of motivation and math anxiety before and after implementing motivation-enhancing strategies, as well as to examine the extent of motivation's influence on student anxiety. This research is expected to yield a clearer empirical understanding of the role of motivation in the affective dynamics of mathematics learning.

Academically, this research contributes to strengthening theories of educational psychology, particularly the relationship between motivation and learning anxiety in the context of elementary education. At the micro level, the results of this study can help students develop positive perceptions of mathematics and foster self-confidence in learning. At the meso level, teachers can utilize the findings of this study to design motivation-based learning strategies that are effective in creating a supportive learning environment and reducing academic anxiety. At the macro level, these findings can form the basis for the formulation of educational policies that emphasize the importance of psychosocial support in mathematics teaching in elementary schools. Thus, this research not only offers empirical contributions but also has scientific and practical impacts on the development of pedagogy that focuses on students' emotional well-being and motivation in mathematics learning.

METHODS

This study employed a quantitative approach with a quasi-experimental design, combined with reflective elements from classroom action research (CAR) to enrich contextual understanding of

changes in student learning behavior. The dominant paradigm in this study was causal effect testing, namely to determine the extent to which increased learning motivation influences decreased students' mathematics anxiety. However, the reflective elements and action cycles of the Kemmis and McTaggart model were adaptively integrated to ensure that pedagogical interventions were not simply implemented mechanically but were also continuously developed through a process of reflection and adjustment between cycles. This hybrid approach is based on the theoretical insights of McNiff and Creswell (Abraham & Supriyati, 2022), who emphasize the potential integration of educational experiments and action reflection to produce more contextual and applicable impacts in elementary school settings.

The interventions in this study consisted of intrinsic motivation-based learning strategies, such as providing autonomy in solving mathematics problems, positive reinforcement, and presenting learning contexts relevant to students' daily lives. These strategies were implemented consistently in each cycle but were refined based on teacher and researcher reflections following field observations. The research was conducted in two two-week action cycles, each lasting two weeks, with each cycle encompassing planning, action, observation, and reflection. Intervention fidelity was maintained through regular coordination between the researcher and classroom teachers, as well as the use of standardized implementation guidelines.

The study population included all fourth-grade students from two public elementary schools in the Ki Hajar Dewantara cluster, Gemolong District, Sragen Regency. The two schools were selected purposively due to their relatively similar demographic characteristics, including socioeconomic background, academic achievement, and access to educational resources. Sampling was conducted using a cluster random sampling technique, where cluster units are defined based on naturally occurring classes. From the four classes in the two schools, a total of 95 students were selected as the research sample. This selection was based on participant availability and practical considerations in the field, rather than on formal statistical power analysis. Each class consisted of 23–24 students, with two classes serving as intervention groups and two as control groups. Due to the limited number of clusters (four classes), the term "random" here is more accurately understood as limited randomization between classes, which maintains a balance of baseline characteristics between groups.

The research instrument consisted of two main questionnaires: a learning motivation scale and a mathematics anxiety scale. The learning motivation questionnaire was developed based on Self-Determination Theory to measure students' intrinsic and extrinsic motivational dimensions. Meanwhile, the mathematics anxiety scale was adapted from the Mathematics Anxiety Rating Scale (MARS) by Richardson & Suinn (Arifa & Utaminingtyas, 2024), with language modifications to suit the cognitive developmental level of elementary school students. The instrument adaptation process involved translation and back-translation procedures, a limited pilot test on 30 students, and simplification of the language and the addition of visual illustrations to ensure understanding for respondents aged 9–10 years. Content validity was tested by three experts with expertise in educational psychology and learning evaluation using the Aiken's V index, while construct validity was confirmed through exploratory factor analysis (EFA). The instrument's reliability was tested on a pilot sample, with a Cronbach's Alpha value of 0.84 for the motivation scale and 0.81 for the math anxiety scale, indicating adequate internal consistency.

All research procedures obtained ethical approval from the relevant educational institutions and written consent from parents or guardians. The questionnaire was completed voluntarily under the guidance of the class teacher, with guaranteed data confidentiality and respondent anonymity. To minimize social desirability bias, teachers were involved only for technical supervision, without providing any direction that could influence student responses. The questionnaires took between 20 and 25 minutes to complete.

Data analysis was conducted using descriptive and inferential statistics using SPSS version 25.0 software. Descriptive analysis was used to describe the distribution of learning motivation and math anxiety. Prior to hypothesis testing, assumptions of normality (Kolmogorov-Smirnov test), homogeneity (Levene's test), and multicollinearity and homoscedasticity were tested to ensure the data fit the regression model. A split-sample t-test was used Pairwise regression analysis was used to compare pretest and posttest results between cycles, while simple linear regression analysis was used to examine the effect of learning motivation on mathematics anxiety. However, due to the quasi-experimental nature of the design and the presence of initial differences between groups, analysis of covariance (ANCOVA) was also used as an additional control measure for pretest scores to enhance

the internal validity of the findings. The results of the analysis are reported with effect sizes (Cohen's d and R^2) to provide a more meaningful interpretation beyond statistical significance (p-value).

Table 1. Operational Definition of Variables

Variable	Operational Definition	Indicator	Instrument	Scale
Learning Motivation (X)	Internal and external drives that move students to be actively involved in learning mathematics and persist in facing academic challenges.	1. The need for competence 2. The need for autonomy 3. The need for social connection 4. Learning goal orientation 5. Perseverance in learning	Learning Motivation Questionnaire (25 items)	Likert 1-4
Math Anxiety (Y)	Feelings of tension, worry, and fear experienced by students when facing math learning situations, working on problems, or math evaluations.	1. Anxiety when working on problems 2. Anxiety when taking tests 3. Anxiety in learning 4. Physical symptoms of anxiety 1. 5. Avoidance of math	Math Anxiety Scale (20 items)	Likert 1-4

RESULTS AND DISCUSSION

Level of Motivation to Learn Mathematics Before and After Strategy Implementation

Based on data analysis of 95 fourth-grade students, findings indicated a substantial increase in mathematics learning motivation after the implementation of intrinsic motivation-based learning strategies. Statistically, the average learning motivation score increased from 54.82 (SD = 6.85) before the intervention to 67.34 (SD = 7.12) after the intervention, with an average increase of 12.52 points, experienced by 89.47% of students. This increase not only indicates a numerical change but also reflects a meaningful affective and cognitive transformation in the students.

Theoretically, this increase reinforces the assumption of Self-Determination Theory that providing autonomy, competency support, and social connectedness in the classroom can enhance students' intrinsic motivation (Audina & Dewi, 2021). In a pedagogical context, these results indicate that when students are actively engaged through learning approaches relevant to their experiences, they demonstrate increased interest, persistence, and confidence in facing mathematics challenges. Thus, these changes in scores not only reflect the success of the intervention in increasing learning motivation, but also mark a shift in learning orientation from mere compliance with tasks to more meaningful and autonomous engagement.

Table 2: Descriptive Statistics of Mathematics Learning Motivation

Measurement Time	N	Mean	SD	Min	Max	Improvement
Before	95	54.82	6.85	37	68	-
After	95	67.34	7.12	48	82	12.52

The results of the paired-sample t-test showed a highly significant difference between levels of learning motivation before and after implementing an intrinsic motivation-based learning strategy (t(94)

= –15.85, p = 0.000). The very large effect size (Cohen's d = 1.81) indicates that the intervention had a strong practical impact on increasing students' learning motivation. Theoretically, this finding aligns with the Self-Determination Theory framework (Prasetyo & Dasari, 2023), which asserts that when students' basic psychological needs—namely autonomy, competence, and social connectedness—are met, their intrinsic motivation significantly increases. In the context of mathematics learning, this increased intrinsic motivation not only leads to higher cognitive engagement but also plays a role in reducing anxiety because students feel more in control of the learning process and are more confident in their abilities.

From an educational psychology perspective, higher motivation serves as a buffer against emotional distress, as intrinsically motivated students tend to interpret mathematical challenges as opportunities for growth, rather than threats to their academic self-esteem. The effect size found in this study (d = 1.81) even exceeds the average effect size reported in similar studies, which generally ranges from 0.60 to 1.20 (Alaeddin et al., 2019). Thus, these results indicate that the applied motivation-based learning strategy is not only statistically effective but also pedagogically powerful in strengthening motivation and reducing mathematics anxiety in elementary school students.

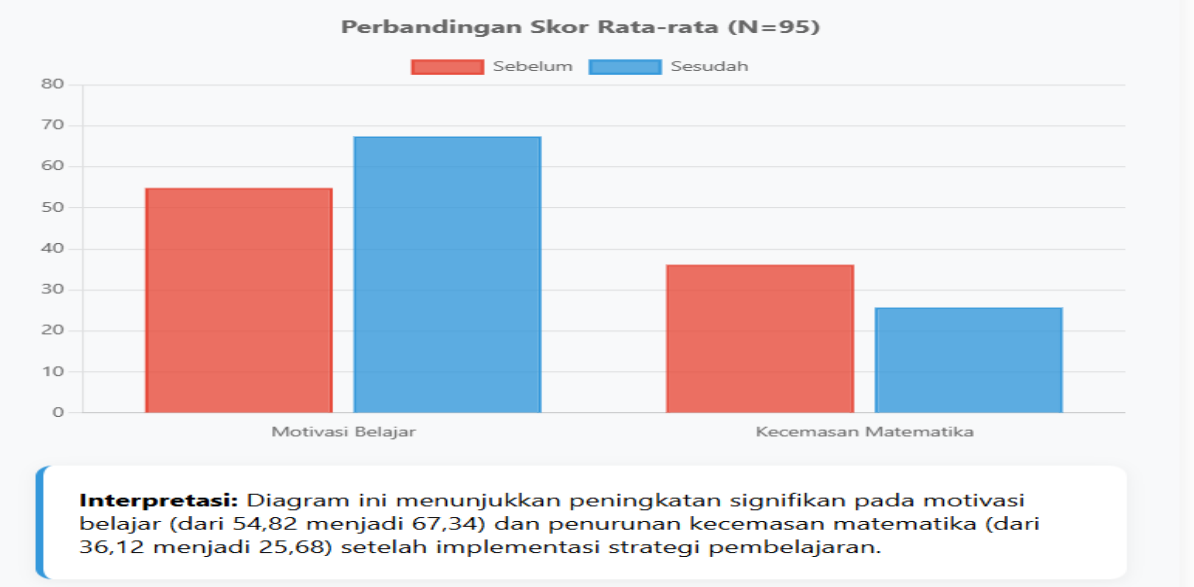

Figure 1: Comparison of Mean Score Before and After Implementation

Math Anxiety Level Before and After Strategy Implementation

Analysis of math anxiety levels showed a consistent and significant decrease after the implementation of intrinsic motivation-based learning strategies. Before the intervention, students' average math anxiety score was 36.12 (SD = 9.84) with a score range of 20–64. After the intervention, the average score decreased to 25.68 (SD = 7.91) with a score range of 20–52, representing a decrease of 10.44 points. A total of 91.58% of students experienced a decrease in anxiety levels, indicating that the intervention not only increased learning engagement but also reduced negative emotional responses to mathematics.

This reduction in anxiety was paralleled by a 12.52-point increase in learning motivation, indicating a reciprocal relationship between increased cognitive engagement and academic emotional regulation. Within the framework of Self-Determination Theory, when students' psychological needs—particularly autonomy and competence—are met through learning strategies that support intrinsic motivation, students feel more in control of their learning process. This sense of competence reduces the perceived threat of mathematics tasks, resulting in a significant reduction in learning anxiety. Pedagogically, these findings suggest that increased motivation not only serves as a driver of academic performance, but also as an effective emotional regulation mechanism in helping students face mathematical challenges more calmly, confidently, and adaptively.

Table 3. Descriptive Statistics of Math Anxiety

Measurement Time	N	Mean	SD	Min	Max	Decrease
Before	95	36,12	9,84	20	64	-
After	95	25,68	7,91	20	52	10,44

The paired sample t-test showed a highly significant difference in math anxiety levels before and after implementation (t = 12.396, df = 94, p = 0.000). The results of a paired-sample t-test showed that the reduction in math anxiety after implementing an intrinsic motivation-based learning strategy was statistically significant, with a large effect size (Cohen's d = 1.16). This value indicates that the intervention had a substantial practical impact, not just a numerical change. Theoretically, these results support the view in Self-Determination Theory that when students' basic psychological needs—particularly a sense of competence and autonomy—are met, the perception of threat in learning math decreases, thus reducing learning anxiety. With increased intrinsic motivation, students tend to interpret math tasks as challenges to be mastered, rather than as sources of stress, resulting in greater self-confidence and improved emotional regulation.

Compared with previous research, this effect size is higher than average. Math anxiety intervention studies generally report Cohen's d values ranging from 0.50 to 0.90, as reported by (Ramirez et al., 2018) in their study on the influence of motivational strategies and self-efficacy-based approaches on elementary school students' math anxiety. Thus, the d value of 1.16 in this study indicates that an intrinsic motivation-based approach produces a stronger impact than conventional interventions that only focus on reducing anxiety without strengthening students' internal motivation. Pedagogically, this implies that efforts to reduce math anxiety will be more effective when combined with strategies that foster autonomous motivation, rather than simply providing practice or cognitive support.

Effect of Learning Motivation on Math Anxiety

Simple linear regression analysis was conducted to examine the effect of learning motivation on math anxiety using post-intervention data. The Kolmogorov-Smirnov normality test results showed normal data distribution (p > 0.05) and Levene's homogeneity test confirmed homogeneity of variance (p > 0.05), so the regression analysis assumptions were met.

Table 4. Simple Linear Regression Analysis Results

Model	R	R^2	Adjusted R^2	F	Sig.
1	0,742	0,551	0,546	114,289	0
Variable	**B**	**SE B**	**β**	**t**	**Sig.**
Constant	71,435	4,127	-	17,316	0
Learning Motivation	-0,681	0,061	-0,742	-10,69	0

The analysis shows that learning motivation has a negative and significant effect on math anxiety (β = -0.742, t = -10.690, p = 0.000). The correlation coefficient of -0.742 indicates a strong negative relationship between the two variables, where an increase in learning motivation is followed by a decrease in math anxiety. The regression model formed is: Math Anxiety = 71.435 - 0.681 × Learning Motivation.

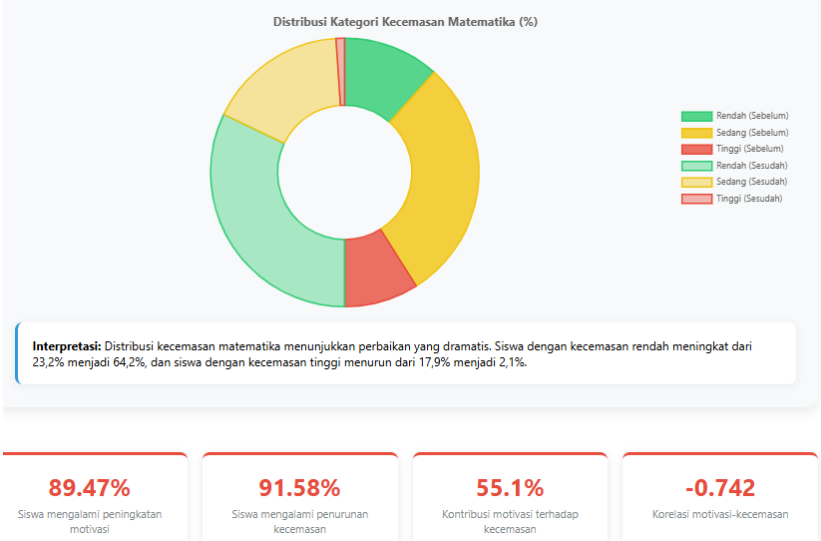

Figure 2: Category Distribution of Math Anxiety

Contribution of Learning Motivation in Reducing Math Anxiety

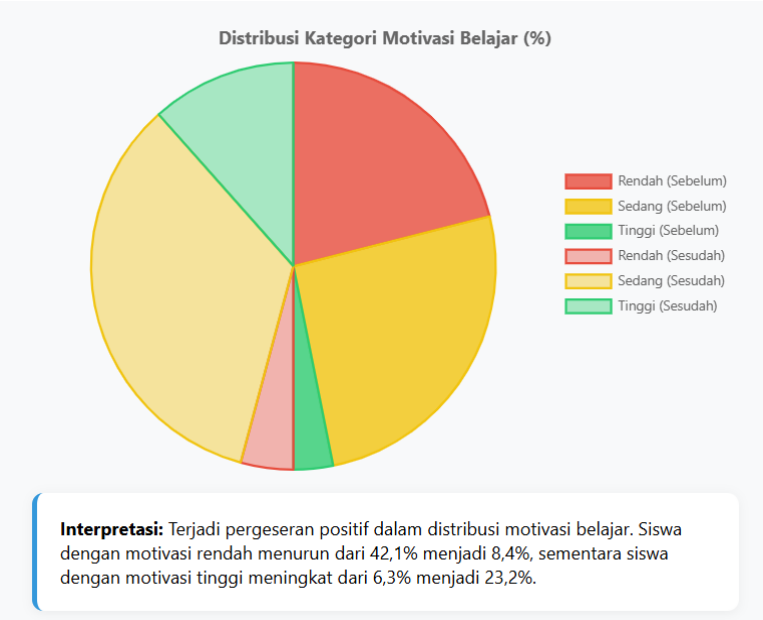

Figure 3. Distribution of Learning Motivation Categories

Based on the coefficient of determination (R^2), learning motivation contributes 55.1% in explaining the variance of math anxiety in 4th grade students. This means that 55.1% of the variation in math anxiety levels can be explained by the level of student learning motivation, while the remaining 44.9% is influenced by other factors not examined in this study.

Table 5. Categorization of Learning Motivation and Mathematics Anxiety

Category	Learning Motivation		Math Anxiety	
	Before	After	Before	After
Low (%)	42.1	8.4	23.2	64.2
Medium (%)	51.6	68.4	58.9	33.7
High (%)	6.3	23.2	17.9	2.1

Further analysis using categorization showed a dramatic shift in the distribution of motivation and anxiety levels. The percentage of students with low learning motivation decreased from 42.1% to 8.4%, while students with high motivation increased from 6.3% to 23.2%. In contrast, the percentage of students with low math anxiety increased from 23.2% to 64.2%, and students with high anxiety decreased dramatically from 17.9% to 2.1%.

The findings of this study confirm that strategies for increasing learning motivation have a significant impact on reducing math anxiety in fourth-grade elementary school students. The analysis revealed a strong negative correlation between learning motivation and math anxiety ($r = –0.742$), with a variance contribution of 55.1%, meaning that more than half of the variation in math anxiety levels can be explained by changes in learning motivation. This finding strengthens the empirical basis that learning motivation is a crucial predictor in reducing students' emotional distress about mathematics.

From a theoretical perspective, these results are consistent with Self-Determination Theory, which emphasizes the importance of fulfilling basic psychological needs—autonomy, competence, and social relatedness—in fostering intrinsic motivation. When students feel in control of their learning process (autonomy), believe in their abilities (competence), and receive social support from teachers and peers (relatedness), the perceived threat in learning mathematics naturally decreases (Lestari et al., 2022). In other words, math anxiety is not only a cognitive phenomenon, but also an affective and social phenomenon, which can be transformed through learning experiences that foster autonomous motivation.

Pedagogically, these findings have direct implications for classroom teachers and curriculum designers. Teachers need to design mathematics learning that is not solely outcome-oriented, but also focuses on strengthening students' intrinsic motivation. For example, teachers can assign real-life context-based tasks that allow students to make their own choices in solving problems (enhancing autonomy), provide formative feedback that confirms individual progress (strengthening competence), and encourage collaborative group work (building social connectedness). This creates a psychologically safe environment in which mistakes are viewed as part of the learning process, rather than as anxiety-inducing failures.

For curriculum designers, these research findings underscore the need to integrate motivation-based approaches into the structure of elementary school mathematics learning. Modules and textbooks should include activities that stimulate curiosity and contextual relevance, rather than simply procedural exercises. A curriculum that prioritizes meaningful and autonomous learning experiences will help students develop positive attitudes toward mathematics from an early age, thereby reducing the risk of learning anxiety later in life.

Thus, this study not only provides empirical evidence of the causal relationship between motivation and anxiety, but also offers a practical pedagogical framework that teachers can implement to create a more enjoyable, adaptive, and emotionally supportive mathematics learning environment. These results provide a basis for developing basic education policies that are more oriented toward students' psychological well-being, rather than solely academic achievement.

Discussion

Levels of Motivation to Learn Mathematics Before and After Strategy Implementation

The research results indicate a significant change in the motivation to learn mathematics among fourth-grade elementary school students after the implementation of motivation-enhancing strategies. Although the empirical data demonstrates a significant increase in motivation scores, it is more important to examine the psychological mechanisms behind these changes. Based on the Self-Determination Theory framework, this improvement is primarily driven by strengthening students' intrinsic motivation and self-efficacy. The implemented learning strategies provide students with the space to make decisions during the learning process, receive positive feedback, and experience a sense of accomplishment in completing math tasks. These conditions strengthen feelings of autonomy and competence, two key elements that play a crucial role in shaping intrinsic motivation. Therefore, the term substantial transformation in this context refers not only to an increase in average motivation scores

but also to a shift in the quality of motivation—from a reliance on external stimuli to a more sustained, autonomous motivation.

These changes can also be seen as part of an effort to recontextualize the mathematics learning experience at the elementary level, where students who previously tended to view mathematics as a stressful activity begin to perceive it as a challenging yet enjoyable exploratory process. This aligns with the findings of Berliani and Persada (in Pd et al., 2021), who confirmed that fun and participatory learning methods can foster positive emotional attachment to mathematics. Psychologically, this attachment reduces the fear of error and increases students' confidence in trying new problem-solving strategies.

Globally, the results of this study resonate with international findings such as the OECD and TIMSS reports, which show that students with high levels of intrinsic motivation tend to have better mathematics performance and lower levels of anxiety. However, compared with the OECD average, which shows only around 36% of students have positive beliefs about their mathematics abilities, the findings of this study demonstrate a much larger motivational shift in the local Indonesian context. This suggests that well-planned motivation-based interventions can have a significant impact, even in a learning culture that is generally oriented towards results and formal evaluation.

While the results of this study make an important contribution to understanding the relationship between motivation and mathematics anxiety, there are several limitations that should be noted. First, motivation measurements were conducted over a relatively short period of time, so the long-term effects of this intervention are uncertain. Second, this study focused on a single educational level and school context, so generalizations to broader populations should be approached with caution. Further research is recommended to examine the dynamics of motivation in online and collaborative learning contexts, as well as to explore the role of teacher and peer social support as mediators of the relationship between motivation and math anxiety.

Thus, the results of this study not only demonstrate quantitative improvements in motivation scores but also underscore the importance of qualitative transformations in students' thinking patterns and attitudes toward mathematics. Motivation-based learning strategies have been shown to foster curiosity, self-efficacy, and courage to face challenges, which are foundational to more humanistic and sustainable mathematics learning.

Math Anxiety Levels Before and After Strategy Implementation

Analysis of math anxiety levels showed a consistent and statistically significant decrease after implementing strategies to increase learning motivation. The initial condition showed a mean anxiety score of 36.12 with a standard deviation of 9.84, reflecting a relatively high level of anxiety among elementary school students. This finding is consistent with the research of Berliani and Persada (2024), which confirmed that psychological symptoms of anxiety are negatively correlated with academic performance in mathematics. After implementing the strategies, the mean anxiety score decreased to 25.68 with a standard deviation of 7.91, indicating the intervention's effectiveness in reducing emotional distress experienced by students. The large effect size (Cohen's $d = 1.16$) confirms that the impact of this change is not only statistically significant but also practically and psychologically meaningful.

Theoretically, this decrease in anxiety can be explained through the framework of Self-Determination Theory. Increased intrinsic motivation fostered through learning that supports autonomy, competence, and social connectedness plays a role in reducing evaluative pressure and fear of failure (Saraswati & Kusumaningrum, 2024). When students feel more competent and in control of their learning process, their physiological stress responses are reduced, and the learning experience becomes more enjoyable. In other words, increased self-confidence and a supportive learning environment directly reduce anxiety levels. This aligns with the findings of Shao et al. (2025) that high levels of anxiety hinder mathematical problem-solving abilities, while feelings of self-confidence increase cognitive flexibility in facing numerical challenges.

Furthermore, these results resonate with cross-cultural research confirming the link between autonomous motivation and reduced academic anxiety. Desi et al. (2024) showed that students who received autonomy support from teachers tended to experience significant decreases in test anxiety and

increased learning persistence. Similarly, an OECD report revealed that in countries with learning systems that emphasize autonomy and emotional support, students reported consistently lower levels of math anxiety compared to those in learning contexts that focus on outcome assessment (Yang et al., 2025). Therefore, the decrease in anxiety experienced by 91.58% of students in this study is not simply a reflection of increased motivation but also an indication of the intervention's success in changing the emotional and social climate of mathematics learning. The implication for pedagogical practice is that teachers need to create learning environments that encourage self-expression and experimentation, rather than simply emphasizing correct answers. Motivation-oriented learning strategies—for example, through contextual tasks, rewards for effort, and opportunities for self-reflection—have been shown to reduce anxiety while increasing students' emotional engagement. Thus, these findings reinforce the view that successful mathematics learning depends not solely on cognitive abilities but also on the balance between students' emotional regulation and intrinsic motivation.

Effect of Learning Motivation on Math Anxiety

A simple linear regression analysis revealed a highly significant negative relationship between learning motivation and math anxiety in fourth-grade elementary school students. The correlation coefficient of -0.742 indicates a strong negative relationship, indicating that increases in learning motivation are consistently accompanied by decreases in math anxiety. The regression model revealed that each one-unit increase in learning motivation correlates with a 0.681-unit decrease in anxiety, with a constant of 71.435. Practically, this means that when students demonstrate a higher drive to learn—such as a willingness to try new problem-solving strategies, actively participate in class discussions, or dare to ask questions when experiencing difficulties—they tend to show a decrease in observable anxiety symptoms, such as avoiding assignments, hesitating to answer questions, or exhibiting nervous behavior during exams. In other words, increased intrinsic motivation plays a direct role in increasing students' self-confidence and emotional well-being in math learning situations.

Theoretically, this relationship can be explained through Self-Determination Theory, which emphasizes that intrinsic motivation grows through three basic psychological needs: autonomy, competence, and relatedness. In the classroom context, these three components are concretely manifested through various learning activities implemented in this study. For example, autonomy is developed through opportunities for students to choose their own problem-solving approaches; competencies are reinforced through positive feedback and process-based assessments that emphasize effort over outcomes; and social connectedness is built through group work and collaborative interactions that reduce the fear of negative evaluation from teachers and peers. When these three elements are met, students experience an increased sense of control, self-confidence, and social support—which psychologically reduce the activation of the stress system and academic anxiety.

These findings align with previous research in Indonesia (Luhinar & Nugreheni, 2024; Ulfa, 2023), which shows that learning motivation and self-efficacy play a significant role in suppressing math anxiety and improving critical thinking and problem-solving skills. Globally, these results are consistent with the findings of Ramirez et al. (Ramirez et al., 2018), which confirmed that a learning environment that fosters goal-oriented motivation can reduce anxiety and increase learning persistence in challenging subjects like mathematics. Furthermore, an OECD report indicates that students with high levels of autonomous motivation exhibit 30–40% lower levels of math anxiety than students whose motivation is driven by external pressures.

Thus, these regression results not only demonstrate a statistical relationship between the two variables but also emphasize the importance of a pedagogical approach focused on strengthening intrinsic motivation as a key strategy in creating a safe, supportive, and stress-free learning environment. Practical implications: Teachers can utilize learning strategies that allow for autonomy, self-reflection, and positive reinforcement, so that the anxiety reduction reflected in the statistics actually manifests itself in more confident, engaged, and productive learning behaviors in the classroom.

Contribution of Learning Motivation in Reducing Math Anxiety

Based on the coefficient of determination (R^2) analysis, learning motivation contributed a substantial 55.1% to explaining the variance in mathematics anxiety in fourth-grade elementary school

students. This figure indicates that more than half of the variation in mathematics anxiety can be explained by students' level of learning motivation, thus serving as a key predictor in understanding students' emotional dynamics towards mathematics learning. The remaining 44.9% was influenced by external factors not examined in this study, such as family support, variations in teaching strategies, and students' personality characteristics and self-efficacy. These results align with the findings of Evangelopoulou (Evangelopoulou, 2024), who showed that limited teaching methods and a low-supportive learning environment exacerbated mathematics learning difficulties.

Theoretically, these findings can be explained through the framework of Self-Determination Theory, which emphasizes that intrinsic motivation grows when three basic psychological needs are met: autonomy, competence, and social relatedness. In the learning context applied in this study, autonomy is realized through the opportunity for students to choose how to solve problems and set their own learning goals. Competence is strengthened through formative feedback and challenging yet accessible problem-solving activities; while social connectedness is built through group collaboration and positive support from teachers and peers. When these three aspects are facilitated, students experience increased self-confidence and a sense of meaning in their learning, which directly reduces anxiety because they feel they have control and emotional support in the learning process. These findings are supported by Rodríguez-Menchón et al. (Rodríguez-Menchón et al., 2021), who confirmed that learning environments that meet the needs for autonomy and competence significantly reduce academic anxiety and increase students' cognitive engagement across various cultural contexts.

Practically, the regression model generated from this study can be used as an early diagnostic tool for teachers and school counselors. For example, through regular motivation-anxiety screening, educators can identify students with low motivation who are at risk of developing high levels of math anxiety. This early detection allows for more targeted interventions, such as implementing an autonomy-based learning approach, providing individualized emotional support, or strengthening self-efficacy through reflection on learning outcomes. This data-driven diagnostic approach has the potential to improve the efficiency of tutoring programs and reduce students' emotional burden early on.

Furthermore, these findings also offer implications for education policy. Enhancing learning motivation should not only be a classroom focus but also an explicit component of teacher training programs and national curriculum design. A curriculum that emphasizes a balance between cognitive and affective outcomes can help teachers understand that anxiety is not simply an emotional symptom but rather an indicator of unmet psychological needs. Therefore, learning policies that promote a humanistic, student-centered approach can simultaneously strengthen emotional well-being and academic outcomes.

While the results of this study demonstrate a strong contribution of motivation to math anxiety, several limitations should be acknowledged to maintain scientific transparency. First, the study design used a non-random cluster sample from two schools in a semi-urban area, so generalizing the findings to a broader population requires caution. Second, data were obtained through self-report questionnaires, which could potentially be influenced by social bias or students' perceptions of teachers. Third, local cultural factors such as hierarchical teaching styles and collectivistic orientations may contribute to shaping this motivation-anxiety relationship, so the results need to be tested across contexts or regions to strengthen external validity. Future research is recommended to integrate mixed-method approaches to more deeply explore the student psychological dynamics behind the quantitative relationships found.

CONCLUSIONS

This study provides strong empirical evidence that learning motivation plays a significant role in reducing math anxiety in fourth-grade elementary school students. Motivation levels increased substantially, while math anxiety decreased dramatically, reflecting the overall effectiveness of the implemented motivation-based learning strategies. These results indicate that increased motivation not only serves as a cognitive drive for learning but also as a protective factor against affective barriers that often arise in the context of mathematics learning.

Theoretically, these findings align with Self-Determination Theory, which emphasizes the importance of fulfilling the needs for autonomy, competence, and social relatedness in fostering students' intrinsic motivation and emotional well-being. When students feel in control of their learning, are able to achieve success through their own efforts, and receive positive social support, academic anxiety tends to decrease significantly. Furthermore, these results reinforce the Affective-Cognitive Model of Motivation and Emotion, which explains that negative emotional experiences such as anxiety can be suppressed by increasing intrinsic motivation and perceived control over academic tasks. Thus, this study broadens our understanding of the role of motivation as a protective mechanism in the context of math anxiety in elementary school-aged children.

However, this study has several methodological limitations that should be noted. The study sample consisted of 95 students from two elementary schools in a semi-urban area, so generalizing the results to other contexts requires caution. This study's quasi-experimental design, while capable of demonstrating limited causality, still relies on self-report data, potentially biased by students' perceptions of their learning experiences. Furthermore, this study did not explicitly consider gender and socioeconomic status (SES) variables, which may moderate the relationship between motivation and anxiety. Therefore, further research with longitudinal designs and cross-cultural samples is needed to validate the stability of this relationship in broader contexts.

Practically, the results of this study have important implications for the development of learning policies and strategies. Teachers and school counselors can utilize the motivation-anxiety diagnostic model to periodically assess students' psychological well-being, allowing interventions to be tailored to individual needs. Motivation-boosting strategies can be integrated through teacher training, the use of adaptive digital learning media, or reflective activities that foster student autonomy and competence. At the policy level, these results can also inform teacher training programs that emphasize the affective aspects of mathematics learning, rather than solely the cognitive aspects. Overall, this research confirms that learning motivation is not simply a supporting variable, but rather a psychological foundation that protects students from academic anxiety. With an approach that focuses on students' psychological needs and motivation-based interventions, mathematics learning can become a more positive, meaningful, and sustainable experience for elementary school students.

REFERENCES

Abraham, I., & Supriyati, Y. (2022). Desain Kuasi Eksperimen Dalam Pendidikan: Literatur. *Jurnal Ilmiah Mandala Education*, *8*(3).

Alaeddin, O., Khattak, M. A., & Abojeib, M. (2019). Evaluating stability in dual banking system: comparison between conventional and Islamic banks in Malaysia. *Humanities & Social Sciences Reviews*, *7*(2), 510–518.

Arifa, A. F., & Utaminingtyas, S. (2024). Penerapan joyful learning terhadap hasil belajar matematika peserta didik kelas iv sekolah dasar: penerapan joyful learning terhadap hasil belajar matematika peserta didik kelas iv sekolah dasar. *DIKDASTIKA: Jurnal Ilmiah Pendidikan Ke-SD-An*, *10*(1).

Audina, R., & Dewi, D. F. (2021). Analisis Faktor Penyebab Kesulitan Belajar Matematika Kelas IV Sekolah Dasar Negeri 105364 Lubuk Rotan. *All Fields of Science Journal Liaison Academia and Sosiety*, *1*(3), 147–158. https://doi.org/10.58939/afosj-las.v1i3.213

Desi, Z., Pramista, A. Z. S., Alfarisi, M. S. R. S., & Amaliyah, F. (2024). Relationship Between Mathematical Anxiety Levels and Mathematics Learning Outcomes. *Riemann: Research of Mathematics and Mathematics Education*, *6*(3), 335–342. https://doi.org/10.38114/reimann.v6i3.49

Evangelopoulou, M. (2024). *Teacher's awareness of the impact of mathematics anxiety in the performance of students with and without mathematics learning disabilities*.

Lestari, N. P. P., Ardana, I. M., & Suryawan, I. P. P. (2022). Analisis Motivasi Belajar Matematika Beserta Alternatif Solusinya pada Siswa Kelas X SMA Negeri 5 Denpasar di Masa Pandemi.

Wahana Matematika Dan Sains: Jurnal Matematika, Sains, Dan Pembelajarannya, *16*(1), 40–51. https://doi.org/10.23887/wms.v16i1.42017

Luhinar, W., & Nugreheni, N. (2024). Pengaruh motivasi belajar, efikasi diri, dan kecemasan Matematika terhadap kemampuan pemecahan masalah Matematika. *Elementary School Teacher*, *7*(1), 1–13. https://doi.org/10.15294/22654p11

Mawansyah, J. (2024). Digital Transformation of Village Finance: Web-Based SISKEUDES Design for Enhancing Transparency and Accountability in Naru Village, Bima Regency. *Journal of Intelligent Decision Support System (IDSS)*, *7*(2), 188–196. https://doi.org/10.35335/idss.v7i2.229

OECD. (2023). *PISA 2022 Results (Volume I) The State of Learning and Equity in Education*.

Pd, A. M., Rini, N., & Parida, L. (2021). Analisis Faktor-Faktor Yang Mempengaruhi Rendahnya Hasil Belajar Siswa Pada Pelajaran Matematika. *J-PiMat: Jurnal Pendidikan Matematika*, *3*(1), 295–306. https://doi.org/10.31932/j-pimat.v3i1.1129

Persada, Y. I. (2024). Pengaruh gejala psikologis kecemasan terhadap hasil belajar siswa kelas iv dalam pembelajaran matematika di sekolah dasar. *Ebtida': Jurnal Pendidikan Dasar Islam*, *4*(2), 439–449.

Prasetyo, F., & Dasari, D. (2023). Studi Literatur: Identifikasi Kecemasan Matematika dan Motivasi Belajar Terhadap Hasil Belajar Matematika Siswa. *RANGE: Jurnal Pendidikan Matematika*, *4*(2), 240–253. https://doi.org/10.32938/jpm.v4i2.3649

Ramirez, G., Shaw, S. T., & Maloney, E. A. (2018). Math anxiety: Past research, promising interventions, and a new interpretation framework. *Educational Psychologist*, *53*(3), 145–164. https://doi.org/10.1080/00461520.2018.1447384

Rodríguez-Menchón, M., Orgilés, M., Fernández-Martínez, I., Espada, J. P., & Morales, A. (2021). Rumination, catastrophizing, and other-blame: the cognitive-emotional regulation strategies involved in anxiety-related life interference in anxious children. *Child Psychiatry & Human Development*, *52*(1), 63–76.

Rodríguez, S., Estévez, I., Piñeiro, I., Valle, A., Vieites, T., & Regueiro, B. (2021). Perceived competence and intrinsic motivation in mathematics: Exploring latent profiles. *Sustainability*, *13*(16), 8707.

Saraswati, P., & Kusumaningrum, B. (2024). Analisis Tingkat Kecemasan Matematika Siswa SMA Kelas X dalam Pembelajaran Fungsi Kuadrat. *Edumatnesia: Prosiding Seminar Nasional Matematika Dan Pendidikan Matematika*, *1*(1), 390–397.

Shao, J., Abdul Rabu, S. N., & Chen, C. (2025). The impact of gamified interactive e-books incorporating metacognitive reading strategies on Chinese elementary students' mathematical reading comprehension, word problem-solving performance, and general reading motivation. *Education and Information Technologies*, 1–37.

Ulfa, J. S. (2023). *Peranan guru dalam upaya meningkatkan otivasi belajar siswa*.

Yang, Y., Chen, J., & Zhuang, X. (2025). Self-determination theory and the influence of social support, self-regulated learning, and flow experience on student learning engagement in self-directed e-learning. *Frontiers in Psychology*, *16*, 1545980. https://doi.org/10.3389/fpsyg.2025.1545980