Beliefs about mathematics teachers, anxiety, and academic satisfaction

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Abstract

The objective of this study was to evaluate a model that predicts anxiety and academic satisfaction of mathematics students based on their beliefs about their mathematics teacher and the mathematical context. Surveys researching the above constructs were collected from 428 first-semester students from different fields of study with a high component of mathematical content in their curricula. The data were analyzed using partial least squares structural equation modeling (PLS-SEM). The results increase knowledge about the impact of students' beliefs by showing positive relationships between beliefs about the teacher and academic satisfaction, partially mediated by mathematics anxiety.

Keywords*:* mathematics education, emotions, academic achievement, multivariate analysis

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Creencias sobre maestros de matemáticas, ansiedad y satisfacción académica

Resumen

El objetivo fue evaluar un modelo que predice la ansiedad matemática y la satisfacción académica de los estudiantes en función de sus creencias sobre el profesor de matemáticas y el contexto matemático. Se recopilaron encuestas que investigaron los constructos anteriores en 428 estudiantes de primer semestre de diferentes carreras con un alto componente de contenido matemático en sus planes de estudio. Los datos se analizaron mediante modelos de ecuaciones estructurales de mínimos cuadrados parciales (PLS-SEM). Los resultados aumentan el conocimiento sobre el impacto de las creencias de los estudiantes al mostrar relaciones positivas entre las creencias sobre el docente y la satisfacción académica, mediadas parcialmente por la ansiedad matemática.

Palabras clave*:* educación matemática, emociones, rendimiento escolar, análisis multivariado

Crenças sobre professores de matemática, ansiedade e satisfação acadêmica

Resumo

O objetivo era avaliar um modelo que prevê a ansiedade matemática e a satisfação académica dos alunos com base nas suas crenças sobre o professor de matemática e o contexto matemático. Foram recolhidos questionários que investigavam os conceitos acima referidos junto de 428 alunos do primeiro semestre de diferentes cursos com uma elevada componente de matemática nos seus currículos. Os dados foram analisados utilizando modelos de equações estruturais de mínimos quadrados parciais (PLS-SEM). Os resultados aumentam o conhecimento sobre o impacto das crenças dos alunos, mostrando relações positivas entre as crenças sobre o professor e a satisfação académica, mediadas, em parte, pela ansiedade matemática.

Palavras chave*:* educação matemática • emoções • desempenho acadêmico • análise multivariada

Introduction: Beliefs and mathematics learning

The problems students face in mathematics are not limited exclusively to the inherent complexity of the discipline but are also intrinsically related to their beliefs. Pedersen and Haavold (2023) argue that one difficulty in learning mathematics is that some students need to develop appropriate epistemological beliefs to support their learning of advanced mathematical content. In the educational field, students' belief systems, understood as the conceptions they hold implicitly or explicitly about the teaching of mathematics, the nature and construction of knowledge communicated in the classroom (Muis et al., 2015), about themselves as learners, and about the social environment that surrounds them, play a crucial role, as they are interrelated and closely linked to their prior knowledge about mathematical learning and problem-solving activities in the classroom (Li et al., 2024). These are systems that can manifest themselves through perceptions, ideas, and opinions, which represent the certainties or uncertainties of students about their learning processes (Capote-Castillo et al., 2022).

In this sense, the undeniable and frequent relationships between teachers and students in the classroom indicate that, although teachers cannot guarantee optimal student performance and satisfaction, they do become, by incorporating feedback processes to their students in classroom management, a necessary support and source of emotional, instrumental and evaluative support for the activities developed by their students as a learning mechanism (Sadoughi & Yahya, 2021) or mediators of processes that enhance a better perception of competencies, an increase in autonomy and greater satisfaction in the need for relationships in the classroom (Affuso et al., 2023).

The beliefs of students about mathematics, teachers, and their attitudes towards mathematics influence their opportunities for higher education and their future decisions, leading to high dropout rates associated with mathematical-related subjects during their university studies, a situation particularly visible in Western Hemisphere countries (Rach & Heinze, 2017). In this regard, Di Martino and Gregorio (2019) point out that, while research on cognitive aspects of university mathematics has been prolific, more research is needed on the affective and social elements. Other studies highlight that the perception of support and the relationship with the teacher, together with self-efficacy, are central factors for understanding mathematical motivation and anxiety at different educational stages, and constitute a solid basis for designing innovative pedagogical strategies aimed at well-being and academic success (Juárez-Moreno, Juárez-López, & Hernández-Rebollar, 2025; Wang, Xu, & Fei, 2024).

Furthermore, teachers' own mathematical anxiety is directly transmitted to students. When teachers experience nervousness about their own abilities or about being socially evaluated, this predicts an increase in students' anxiety and a decrease in their mathematical confidence. However, teachers with more experience and positive attitudes can mitigate this negative effect (Smith & Fotou, 2023; Li et al., 2025).

Therefore, it is of great relevance: a) to identify the effect and the relationship between different types of beliefs in the perspective of eliminating obstacles in the learning of mathematics and to propose effective learning strategies that reduce the phenomenon of university dropout (Ji et al., 2021) and b) to assume that students' perspectives or beliefs about their teachers, in which the accompaniment of learning by teachers is a relevant factor for students to learn mathematics, become one of the primary variables in the teaching and learning processes, significantly influencing academic motivation and student performance (Froment & Gutiérrez, 2022; Khine et al., 2018; Li et al., 2024).

Emotions and mathematics learning

Numerous studies indicate that this line of work, which transcends the concern for disciplinary elements, is consolidated thanks to the recovery of studies on emotional phenomena developed at the end of the 20th century. Since then, the idea has consolidated that it is impossible and unacceptable to continue separating rational thinking from emotional phenomena, and, therefore, the need to impact educational settings by projecting a more comprehensive education for students has become more pressing (Damasio, 1994). Thus, in the first half of the twentieth century, the studies of Polya (1945) suggest that problem-solving is a process that involves an emotional struggle. Similarly, the works of Gough (1954) and Dreger & Aiken (1957) are considered as the root of the "mathematical anxiety," construct from terms such as mathematical phobia or numerical anxiety, to refer to the relationship between mathematical activity and anxiety.

Similarly, attitudes towards mathematics play a fundamental mediating role, linking perceived teacher support with academic engagement. Students who receive strong support develop more favorable attitudes, which translates into deeper and more active participation in the discipline (Zhou et al., 2025).

Another essential element to consider is the critique of research on anxiety and mathematics, which points to the need to research, among other aspects, the multidimensional relationships between heterogeneous components such as the trait of mathematics anxiety, the state of mathematics anxiety, attitudes towards mathematics, academic self-concept, cognitive beliefs (Cohen et al., 2021; Orbach & Fritz, 2022) or the perception that students have of their teachers, considering them an excellent support to improve their skills, perseverance or interests and thus achieve greater commitment, self-confidence and the development of more positive attitudes towards mathematics. Other complementary studies related to the emotional component in the university context show that mathematics anxiety, attitudes, and motivation are determining factors in learning calculus, with significant differences according to gender and age, and with confidence as a key predictor of performance (Quiñónes-Méndez et al., 2025). Therefore, there is interest in analyzing how students perceive their mathematics teachers and whether this perception may be one of the factors that also causes mathematical anxiety and, consequently, low academic satisfaction.

Currently, studies suggest that mathematics learning performance declines as a consequence of mathematics anxiety (Wang, 2020). Notably, the meta-analysis conducted by Zhang, Zhao, and Kong (2019) concludes that strong evidence establishes a negative relationship between mathematics anxiety and performance, moderated by cultural variables, educational level, mathematical skills, and personality traits. However, such effects go beyond performance by affecting other aspects of academic relevance, such as attitude towards school and students' happiness, among others, so understanding and intervening aspects of an emotional nature will not only be necessary for a s mathematical success of students but also the entire educational process (Kesici, 2023).

According to Richardson and Suinn (1972), mathematical anxiety, one of the objects this study, implies that

> Feelings of tension and anxiety interfere with manipulating numbers and solving mathematical problems in various every day and academic situations. Mathematical anxiety can prevent a student from passing basic mathematics courses or taking advanced courses in mathematics or science (p. 551).

This situation is reaffirmed in the book Affect and Mathematical Problem Solving by McLeod & Adams (1989) where factors such as beliefs, attitudes, and emotions were assigned a critical role in mathematical problem-solving. In this sense, the present study assumes that mathematical anxiety is a dynamic construct (Rubinsten et al., 2018) linked to elements of a cognitive-intrinsic nature including self-efficacy, self-awareness, and fear (Caviola et al., 2017; Alkan, 2018) and to environmental-contextual factors including parental and teacher support with their teaching strategies (Luneta & Sunzuma, 2022) that envelop everyday life of a subject.

Satisfaction and learning mathematics

Academic satisfaction, a factor of immense importance for educational institutions, is central to the academic and professional outcomes of students (Fangfang et al., 2023). It is not just a determinant of school dropout (Tomás & Gutiérrez, 2019) but also a crucial element in understanding the quality of learning (Vergara et al., 2018). Academic satisfaction significantly impacts the acquired competence and academic performance of students. As Froment and Gutiérrez (2022) suggest, students who are satisfied with their learning experiences are more likely to maintain high levels of motivation and academic performance.

For Kim and Tanis (2022), academic satisfaction represents students' perceptions of their goal-achievement capabilities and an inner sense of achievement. It also covers academic experiences and daily learning-related achievements, reflecting the quality of the learning environment (Meneghel et al., 2019). The findings of Iqbal et al. (2023) further highlight the positive influence of hope and optimism on academic satisfaction, understood as the academic experiences of students compared to the intended learning environment. The diverse influences of academic satisfaction on different educational experiences, such as academic adaptation, social integration, psychological well-being, academic performance, academic success, and student retention, are pointed out by Vergara et al. (2018). In the context of academic satisfaction in engineering, the results obtained by Flores et al. (2021) indicate that academic satisfaction has a significant relationship with student self-efficacy, though not with expectations for positive outcomes or academic persistence, and suggest the possible incidence of cultural and contextual factors in their results.

Given the importance of academic satisfaction and its various influences, this study aims to explore the relationship between students' beliefs about their mathematics teacher and the mathematical context, as well as mathematics anxiety and academic satisfaction. The findings of this research could provide valuable insights for educational researchers, policymakers, and practitioners interested in improving student academic outcomes.

Method

Participants and procedure

The participants in this study were first-semester students at a university in central Colombia. They were taking courses with a high mathematical content, such as Engineering, Geology, Biology, and Natural Sciences, among others, and were studying Basic Mathematics at the time of the survey. To verify the consistency of the instrument over time, it was decided to administer it at two different times and with different students. Thus, the instrument was initially administered at the end of the second semester of 2024 and subsequently at the end of the first semester of 2025. It is important to note that these courses were comprised of students taking the course for the first time and those taking it for the second or third time. It is also important to clarify that the Fundamental Mathematics course broadly addresses topics covered in secondary school.

The surveys were conducted as a group in the same classroom, giving the participants enough time and space to complete them autonomously and confidentially. The completion time ranged between 15 and 30 minutes. The purpose of the study was explained, before starting it, and written informed consent was requested. In obtaining the responses to the different scales evaluated, the participants selected values ranging from 1 = totally disagree to 5 = totally agree.

The sampling was non-probabilistic, following accessibility criteria. A total of 435 students completed the survey but seven were eliminated for providing incomplete or inconsistent information, leaving 428 valid surveys: 301 from the first phase and 127 from the second phase. The first section of the instrument collected descriptive data from the students such as age (Mean=18.7; SD=2.3), gender (Female=41.8%; Male=57.7%; Other=0.5%), type of school from which they graduated (Public=82.9%; Private=16.6%; Validating=0.5%), mother's education (No studies=3.5%; Primary=14.0%; Secondary =49.8%; University=29.9%; No answer=2.8%), father's education (No studies=5.6%; Primary=19.8%; Secondary=38.8%; University=23.8%; No answer=11.9%), among others. It was also recorded that 79.0% of the students had taken the Fundamental Mathematics course for the first time, and the rest were repeating students.

Instruments

The survey aimed to explore the possible relationships between university students' beliefs about their mathematics teachers, the mathematical context, their mathematics anxiety, and their academic satisfaction with mathematics courses. The instrument consisted of four constructs, namely, academic satisfaction, mathematics anxiety, beliefs about the teacher, and beliefs about the mathematical context, with 37 items, as recorded in Table 1.

Table 1. *Source of the items selected for the survey*

Source	Number of items
Beliefs about the role of the teacher in mathematics (Rincón et al., 2022)	6
Beliefs raised by the socio-familiar context (Rincón et al., 2022)	11
Mathematics anxiety (Martínez & Checa, 2014)	12
Academic satisfaction (Vergara et al., 2018)	8

Source: Authors

According to the conceptual framework addressed, the proposed relationships for the previous constructs respond to the following hypotheses: (H1): Beliefs about the mathematics teacher have an adverse effect on mathematics anxiety; (H2): Beliefs about the mathematics teacher have a positive effect on academic satisfaction; (H3): beliefs about the mathematical context have an adverse effect on mathematics anxiety; (H4): beliefs about the mathematical context have a positive effect on academic satisfaction; (H5): Mathematical anxiety harms academic satisfaction.

Accordingly, the proposed research model is shown below in Figure 1. The main objective of the study is to predict the academic satisfaction of the students based on their perceptions of the teacher and the context, mediated by the students' mathematics anxiety.

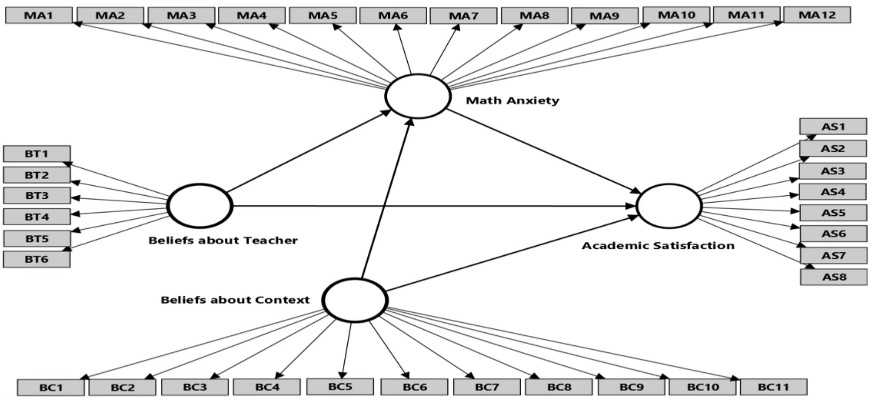

Figure 1. *Research model*

Source: Authors

Data analysis

This exploratory part aims to examine the reliability of the instrument and the data analysis process for future research. It should be noted that the findings of this study are not merely theoretical but have practical implications for first-year students choosing mathematics-related subjects. They can help students understand the importance of their beliefs about mathematics for university level, facilitating their transition and reducing the difficulties they may experience while learning mathematics in higher education.

First, descriptive analyses were conducted to examine general trends and data distribution, identify patterns, and detect potential outliers and asymmetries. Subsequently, a comparative analysis was carried out between the results obtained at two different times to determine whether both samples showed consistent behavior, which would justify the use of a unified sample in subsequent analyses, or whether, on the contrary, it was necessary to work with the samples separately. For this purpose, a mean comparison test was applied to independent samples after verifying the homogeneity of variances between the groups. The results of this analysis, obtained using R software, are presented in Table 2.

Table 2. *Statistical results of the comparison of means*

Variable	Moment		Comparison of variances	Comparison of means	Conclusion
	1	2			
Beliefs about the role of the teacher in mathematics	Mean=3.66 SD=0.60	Mean=3.55 SD=0.65	P=0.257	P=0.095	There are no significant differences
Beliefs raised by the socio-familiar context	Mean=3.38 SD=0.41	Mean=3.36 SD=0.40	P=0.906	P=0.608	There are no significant differences
Mathematical anxiety	Mean=2.96 SD=0.88	Mean=2.96 SD=0.77	P=0.110	P=0.986	There are no significant differences
Academic satisfaction	Mean=3.38 SD=0.88	Mean=3.25 SD=0.84	P=0.620	P=0.154	There are no significant differences

Source: Authors

The absence of statistically significant differences in means and variances suggests that perceptions of students remained stable across the two periods. Consequently, it was decided to continue the analyses with the unified sample.

Subsequently, the robust and widely accepted partial least squares structural equation modeling (PLS-SEM) method, commonly used in exploratory research (Hair et al., 2019), was used to analyze the data collected. This method is classified as a second-generation method, as it allows the incorporation of non-observable or latent variables that are measured indirectly through observable variables or indicators, providing a measure of the error in the observable variables. Particularly, PLS-SEM is a nonparametric method that does not present identification problems when dealing with small sample sizes and is suitable for handling models with complex structures (Hair et al., 2017). The licensed software SmartPLS version 4 (Ringle et al., 2022) calculates the PLS-SEM algorithm.

It should be noted that the implementation of PLS-SEM involves a multi-step process, including specifying the internal and external models, collecting and analyzing data, estimating the structural model parameters, and evaluating the results. Once the internal and external models are specified and the PLS-SEM algorithm is executed, the reliability and validity of the external model constructs are examined, which allow an assessment of the quality of the measurement. To this end, all constructs studied in this research are reflexive. Therefore, Cronbach's alpha and the composite reliability index will be used to assess reliability, with emphasis on the latter, as the former is sensitive to the number of items in the scales and tends to underestimate internal consistency reliability (Hair et al., 2019).

Afterwards, the convergent and discriminant validity of the constructs is examined. Convergent validity is verified when each item has external loadings greater than 0.707, and the AVE (Average Variance Extracted) of each construct is 0.50 or greater (Ringle et al., 2020). The AVE corresponds to the mean value of the squared loadings of a set of indicators if it is equivalent to the communality of the construct. That is, an AVE greater than 0.50 guarantees that the construct explains more than half of the variance of its indicators. On the other hand, discriminant validity represents the degree to which the construct is empirically distinct from other constructs. That is to say, the construct measures what it intends to measure. A method for assessing discriminant validity is the Fornell and Larcker (1981) criterion, which seeks to establish that the construct shares more variance with its indicators than with any other construct. To test this requirement, the square root of the AVE for each construct must be greater than the highest absolute correlation with any other construct. Another option is to examine whether the loadings of each indicator on its construct are greater than the cross-loadings on other constructs. Furthermore, there is the Heterotrait-Monotrait (HTMT) ratio method, where the HTMT ratio value for a set of two constructs with discriminant validity must be less than 0.90 (Henseler et al., 2015).

Next, the hypothesized relationships within the internal model, which is mainly oriented to examine the predictive ability of the endogenous constructs involved are evaluated, following criteria such as the coefficient of determination (R^2), the predictive relevance (Q^2), the path coefficients and the effect size (f^2) of the variables involved. In particular, a rough rule of thumb concerning an R^2 is that values of 0.75, 0.50, and 0.25, respectively, describe substantial, moderate, or weak levels of predictive accuracy (Hair et al., 2017). Likewise, a Q^2 value greater than zero for a particular endogenous construct indicates the predictive relevance of the path model for this particular construct (Sarstedt et al., 2016).

To evaluate the significance of the path coefficients obtained, nonparametric resampling techniques were used, specifically, the bootstrapping process, extracting 5000 samples with replacement. The effect size for each path model was determined by calculating Cohen's f^2, which records the change in R^2 when a specific construct is removed from the model. For reference, effect sizes of 0.02, 0.15, and 0.35 represent small, medium, and large effects, respectively (Hair et al., 2017).

Subsequently, mediation and moderation analyses of the model were performed. Mediation represents a situation in which a mediating variable absorbs, to some extent, the effect of an exogenous variable on an endogenous one in the PLS path model. Therefore, instead of a simple assessment of direct effects, its analysis, provides a more adequate picture of the phenomenon under study. For the calculation of the mediation effects, the bootstrapping process, which does not make any assumptions about the type of distribution of the variables, was used again. Both direct and indirect effects have been examined, obtaining a bias-corrected confidence interval for indirect effects (Hair et al., 2017).

Moderation occurs when the effect of an exogenous construct on an endogenous construct depends on the values of another variable, which influences or moderates the relationship (Hair et al., 2019). Techniques such as multigroup analysis (MGA) are emerging for such a purpose, leading to the evaluation of whether parameters, usually path coefficients, differ significantly between two or more data sets (Ringle et al., 2020). Specifically, multigroup analysis tests the null hypothesis that the path coefficients between the two groups are not statistically different against the alternative hypothesis that the path coefficients are different.

Finally, the goodness-of-fit of the structural model was assessed according to the standardized model, obtaining the standardized root mean square residual (SRMR), which is the only recommended criterion for assessing goodness-of-fit, where a value less than 0.08 would indicate a good model fit (Henseler et al., 2016).

Results

First, factor loading values were used to identify convergent validity. The results presented in Table 3 show that the reliability and convergent validity measures for each construct, except the construct of beliefs about the mathematical context, are above the suggested values.

Table 3. *Statistical* Reliability and convergent validity measures

Variables	Cronbach's Alpha	Composite Reliability	AVE*
Academic Satisfaction	0,930	0,937	0,673
Beliefs about Teacher	0,818	0,825	0,525
Beliefs about Context	0,494	0,441	0,129
Mathematical Anxiety	0,930	0,940	0,571

* AVE: Average Variance Extracted
Source: Authors

Second, the discriminant validity of each variable was examined. The results in Table 4 show that the discriminant validity according to Fornell and Larcker's criteria is satisfactory, except for the construct of beliefs about the context.

Table 4. *Statistical* Reliability and convergent validity measures

	Academic Satisfaction	Beliefs about Context	Beliefs about Teacher	Math Anxiety
Academic Satisfaction	0,821			
Beliefs about Context	0,304	0,359		
Beliefs about Teacher	0,405	0,284	0,725	
Mathematical Anxiety	-0,381	-0,526	-0,364	0,756

Source: Own elaboration based on the results of the SmartPLS software

For the same purpose, Table 5 reports the HTMT values for all constructs, showing that all register values are below 0.9, indicating that the constructs are conceptually different.

Table 5. *Discriminant Validity (HTMT: Hetero-trait-Mono-trait Ratio)*

	Academic Satisfaction	Beliefs about Context	Beliefs about Teacher
Beliefs about Context	0,305		
Beliefs about Teacher	0,456	0,450	
Mathematical Anxiety	0,396	0,413	0,398

Source: Source: Own elaboration based on the results of the SmartPLS software

The compilation of the results obtained so far indicates that the construct beliefs about the teacher, mathematical anxiety, and academic satisfaction meet the quality criteria in terms of reliability and validity, but this is not the case for the construct of beliefs about the context, which is why it is necessary to eliminate this construct from the model.

Next, the evaluation of the respective structural model was carried out. First, possible collinearity problems were assessed by examining the variance inflation factor (VIF) values, obtaining values below 3.3 for all items, thus excluding collinearity problems in the model (Diamantopoulos & Siguaw, 2006). Then, the results obtained from the coefficients of the structural model were analyzed in terms of their sign and significance. Hypotheses H3 and H4 could not be verified, given the elimination of the construct of beliefs about the context from the model. As shown in table 6, beliefs about the mathematics teacher inversely influence the students' mathematical anxiety (Beta=-0.403, $P<0.05$) and positively influence their academic satisfaction (Beta=0.354, $P<0.05$). On the other hand, mathematical anxiety impacts student's academic satisfaction (Beta=-0.232, $P<0.05$). Therefore, hypotheses H1, H2, and H5 are accepted.

Table 6. *Hypothesis assessment*

Hypothesis	Path coefficients	P value	Conclusion
Beliefs about Teacher -> Math Anxiety	-0.403	5.14E-14	Accepted
Beliefs about Teacher -> Academic Satisfaction	0.354	3.97E-09	Accepted
Mathematical Anxiety -> Academic Satisfaction	-0.232	1.36E-06	Accepted

Source: Source: Own elaboration based on the results of the SmartPLS software

Figure 2 presents the final model obtained, with the corresponding external and internal coefficients.

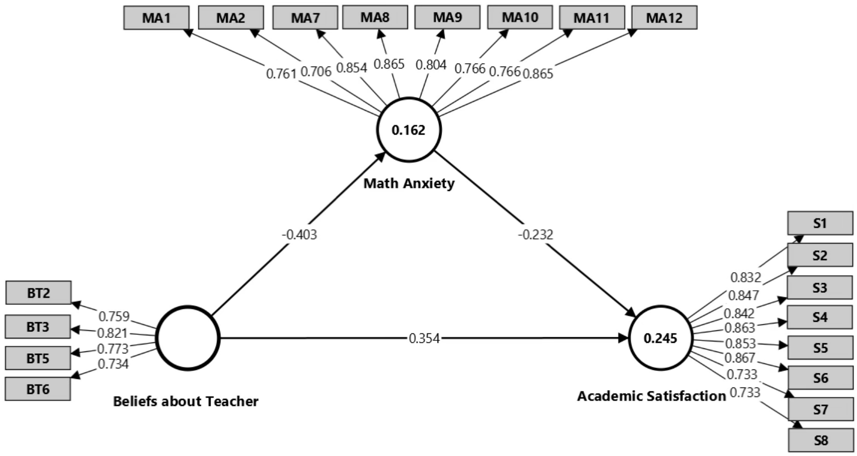

Figure 2. *Model obtained*

Source: Results obtained from SmartPLS software

To assess the predictive capacity of the model, the results obtained for the coefficient of determination of the endogenous variables were analyzed first . As shown in Table 7, the R2 and the adjusted R2 values for academic satisfaction were 0.245 and 0.240, respectively. The mathematical anxiety construct had the values 0.162 and 0.159, respectively. Therefore, the predictive ability of the model can be considered low (Ringle et al., 2020).

Table 7. *Determination coefficients*

	R Square	**R Square Adjusted**
Academic Satisfaction	0.245	0.240
Mathematical Anxiety	0.162	0.159

Source: Source: Own elaboration based on the results of the SmartPLS software

Cohen's f² analysis assesses the effect size of the exogenous variables. As shown in Table 8, the f² value indicates a low effect of mathematical anxiety on academic satisfaction. Beliefs about the teacher have a moderate effect on students' mathematical anxiety and academic satisfaction.

Table 8. *f2 effect sizes*

	Mathematical Anxiety	Academic Satisfaction
Mathematical Anxiety		0,065
Beliefs about Teacher	0,201	0,150

Source: Source: Own elaboration based on the results of the SmartPLS software

Finally, the results obtained in the Q2 test of predictive relevance show that the model predicts endogenous constructs of mathematical anxiety and academic satisfaction by registering Q2 values above zero, precisely 0.14 for the first and 0.19 for the second.

The mediating role of mathematical anxiety in the relationship between students' beliefs about their mathematics teacher and their academic satisfaction was evaluated. This analysis aimed to determine the significance and magnitude of both the direct and indirect effects between the constructs included in the model, and to assess whether the mediation was partial or complete.

Regarding the effects of mediation, Table 9 indicates that mathematical anxiety mediates the relationship between beliefs about the teacher and academic satisfaction.

Table 9. *Mediation effect*

Relation	Indirect effect	Total effect	t value	p value	95% BCCI
Beliefs about Teacher -> Mathematical Anxiety -> Academic Satisfaction	0,093		3,85	0,000	[0.05;0.15]
Beliefs about Teacher -> Academic Satisfaction		0,459	8,98	0,000	[0.36;0.56]

Source: Source: Own elaboration based on the results of the SmartPLS software

The results of the multigroup analysis are discussed below. Different categorical groups were compared, namely, social stratum (low and high), gender (female-male), nature of the school (public-private), whether the student was repeating (no-yes), education level of the mother (university-non-university), education level of the father (university-non-university), origin (urban, periphery, urban), and admission type (regular-other). Regarding this last variable, it should be clarified that the university where the data were collected, in addition to the performance-based admission process known as regular admission, offers other types of admission for students in vulnerable conditions, such as belonging to black or indigenous ethnic groups or coming from regions with high levels of violence, among others. Therefore, comparisons of the model's trajectory coefficients in the different groups mentioned above did not show significant differences, except in the case of the parents' educational variable, where significant differences were recorded for all coefficients ($p<0.05$). Specifically, the relationship between beliefs about teachers, anxiety, and academic satisfaction was intensified in the group of students with parents who attended university. In contrast, the relationship between mathematical anxiety and academic satisfaction weakened in this group.

Finally, regarding the evaluation of the structural model fit, the SRMR value obtained was 0.067, indicating a good fit since it is below 0.08.

Results

This study tests a model to predict how factors related to students' beliefs about their teachers affect mathematical anxiety and academic satisfaction in mathematics courses. Among the findings obtained, a significant relationship was found between beliefs about the mathematics teacher and academic satisfaction, with mathematical anxiety acting as a mediating variable in this relationship.

In line with the findings presented by Henschel and Roick (2017), the results obtained show that the relationship between student beliefs and mathematical anxiety is significant, showing that the personal epistemology of students is intertwined with other aspects such as intellectual development or the development of interpersonal relationships (Markauskaite & Goodyear, 2017). These authors also report that self-efficacy for learning and academic performance are significant predictors of mathematical anxiety in university students. In the same vein, Henschel and Roick (2017) report significant relationships between student beliefs and mathematical anxiety, but they break down each of those constructs. Specifically, student beliefs were divided into two components: control beliefs, i.e., self-concept in mathematics, and value beliefs, i.e., regarding interest in mastery and the outcome of achievement. They found differentiated relationships with cognitive mathematical anxiety, that is, one referring to worry about failure, and affective mathematical anxiety, which leads to nervousness.

The results obtained also coincide with those reported by Iqbal et al. (2023), who indicate that positive expectancy, represented in this case by beliefs about the teacher, is an essential element of academic satisfaction, since positive emotions are associated with a strong sense of control over academic ability. On the contrary, negative emotions can lead students to feel less control over their academic activities and outcomes. Consequently, they dedicate less time and energy to their studies, resulting in lower academic satisfaction (Kim & Tanis, 2022). Likewise, a high level of mathematical anxiety in students can decrease their commitment and lead them to avoid tasks they perceive as threatening (Teheran-Barranco et al., 2024).

Similarly, the results coincide with those presented by Pekrun (2006), where it is evident that emotions are related to the cognitive and metacognitive strategy used by students during their learning, as well as during the different phases of self-regulated learning (planning, monitoring, evaluation, among others) (Muis et al., 2015), as indicated in the previous paragraph.

These results are also consistent with those reported by Zhu & Anagondahalli (2018), who indicate that students' perceptions of teacher credibility affect academic satisfaction, as well as with those results obtained by Froment & Gutiérrez (2022), who found a significant association between teacher perceptions, specifically teacher credibility, and student academic satisfaction. Similarly, Keseci (2023) reports that the attitudes of students towards the school statistically affect their happiness in a positive and significant way, while mathematical anxiety negatively affects their happiness levels. However, in this research, mathematical anxiety was not a mediator but rather a moderator in the relationship between beliefs about the school and student happiness. It was found that, at low levels of mathematical anxiety, the direct effects of a positive attitude toward school on student happiness are more significant than at medium and high levels of mathematical anxiety.

Perceived teacher support, both academic and emotional, is a fundamental resource that not only reduces levels of mathematical anxiety in the classroom but also satisfies basic psychological needs of students for autonomy and competence (Li et al., 2025; Zhou et al., 2025). In this regard, Teheran-Barranco et al. (2024) report having identified that high levels of teacher support are associated with lower anxiety regarding learning and assessment.

Regarding the moderating effect of the paternal education in the model, the literature review did not find any reports on this type of incidence. However, results were found regarding parental influence on the student anxiety academic and satisfaction. Among them, in the context of ninth and tenth-grade high school students, Rubach and Bonanati (2023) found that parental academic support at home was positively related to the intrinsic motivation of students. In turn, greater intrinsic motivation in students leads to less mathematical anxiety. For their part, Ilyas et al. (2023) demonstrated a significant positive association between parental expectations and academic stress, thereby indicating that higher parental expectations are related to higher levels of academic stress in students. However, the relationship between parental expectations and academic stress with academic satisfaction was not significant.

In short, considering the proposals of so-called warm cognition as the basis for teaching processes of specific knowledge domains, such as mathematics, would provide a deeper understanding of how beliefs influence the mathematics learning process.

Limitations

The findings obtained should be interpreted in the context of some limitations. First, probability sampling was not performed, which introduces a selective bias and limits to the representativeness of the results in this study. Second, it is recognized that multiple factors influence academic satisfaction, and the simplification of the study limits its scope. There is an invitation to further exploration of the findings by examining additional constructs, including the size and location of educational institutions, classroom dynamics, university climate, and aspects of family context, among others.

It is also suggested that similar models be tested in other geographic and cultural contexts. Longitudinal studies are also recommended to strengthen causal relationships and examine patterns of change in the model, tracking variables over different periods. As a practical consequence, verifying the adverse effects of mathematical anxiety on indicators of academic success would justify monitoring and supporting students with high mathematical anxiety. Finally, this study tested this model in specific science and engineering-related programs. Future research could examine the model with students from other programs to understand whether these findings can be extrapolated to other educational fields.

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