v. 1, n. 1, 2025

Open Minds
Internacional
Journal

Acceptance date: 08/08/2025

FACTORS ASSOCIATED WITH MATHEMATICS ANXIETY IN TEACHERS IN THE EARLY YEARS OF ELEMENTARY SCHOOL

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Abstract: The objective of this study was to verify factors associated with Mathematics Anxiety (MA) among teachers of the initial years of elementary school in the Public School System of Pelotas/RS, Brazil. This is a cross-sectional study in which 285 teachers participated and answered a self-administered *online* questionnaire containing socio-demographic characteristics, teaching context and items from the *Generalized Anxiety Disorder-7* (GAD-7) and Mathematics Anxiety Scale for practicing teachers (MAST-BR) scales adapted for the Brazilian context. The data was analyzed using the *Statistical Package for the Social Sciences* version 25. The univariate analyses were carried out using absolute and relative frequencies, means and standard deviations; the bivariate analyses were carried out using the *chi-square* test, *Spearman*'s correlation according to the non-normal distribution of the sample and linear regression. The scores on the MAST-BR scale showed significant differences ($p<0.001$), with higher mean scores of MA being identified in teachers from the municipal school system, who declared themselves to be professionally dissatisfied, who did not have specific training for teaching mathematics, who mentioned having a very bad/regular relationship with mathematics and its teaching and who showed anxious symptoms on the GAD-7. The MAST-BR showed a moderate correlation of 0.40 with the GAD-7. We conclude that the most predictive factors for MA were the subjective perception of teachers' relationship with mathematics and its teaching and the presence of symptoms of generalized anxiety.
Keywords: Math Anxiety; Teachers; Elementary School.

INTRODUCTION

It is well known that the first contact with formal mathematics takes place at school, through literacy teachers, i.e. teachers who teach the contents of all subjects; they are the ones who introduce mathematics in the early years of elementary school. In the school context, mathematics is identified as one of the most difficult components of the academic curriculum, generating symptoms of math anxiety (MA).

Most of the existing research on MA is focused on students, where it is seen as a kind of aversion, a feeling of fear or tension that contains an adverse emotional response to the idea of doing math (Dowker *et al*., 2016; Hart and Ganley, 2019), differing from general anxiety (Silva *et al*., 2020) and presenting an inverse relationship with math performance (Hembree, 1990; Carey *et al*. 2017, Zhang *et al*., 2019, Barroso *et al*., 2021).

Identified in international research as a potentially important emotion, MA is experienced particularly by elementary school teachers due to a lack of confidence in their abilities and mastery of mathematical content in these contexts (Beilock *et al*., 2010; Frenzel *et al*., 2016, Ganley *et al*., 2019, Hart and Ganley, 2019). Teachers can experience a range of positive and negative emotions related to teaching, and these emotions can be about meeting the needs of their students, about the subjects they teach or about their ability to teach these subjects (Frenzel *et al.,* 2016; Ganley *et al.*, 2019). Emotions are important for teachers' well-being and are related to the quality of their work. The study by Frenzel *et al.* (2016) seeks to develop instruments in this area, focusing on teachers' anger, pleasure and anxiety in relation to teaching (Frenzel *et al.,* 2016).

The emotional and affective component of MA involves real feelings and uncomfortable physiological reactions. Individuals with MA report negative attitudes and emotions, such

as antipathy and tension (Richardson and Suinn, 1972), frustration (Hembree, 1990) and emotions related to learning outcomes, such as shame and hopelessness (Pekrun *et al.*, 2002).

Research, such as the studies by Beilock *et al.* (2010), report results in which teachers can experience MA, particularly those working in the early years of primary education. The authors state that the anxieties of elementary school teachers can have consequences for their students' math performance (Beilock *et al.*, 2010).

Important studies such as those by Silva *et al.* (2020) focus on the neural component of ML, which also needs to be considered. The authors state that two networks have been found that represent the emotionality of MA: the "pain network" involving the insula, where in the anticipation of an imminent mathematical task it was noticeable to verify the high degree of activity in the bilateral posterior insular cortices, suggesting greater activity in regions associated with the experience of visceral pain (Lyons and Beilock, 2012) and the "fear network" centered on the amygdala, where MA is directly associated with abnormal activity in the right amygdala (Young *et al.*, 2012). Corroborating this theme, Pellicioni *et al.* (2016) state that individuals with MA showed hyperactivity in the emotional areas of the brain in the region of the amygdala and insula, reduced activity in controlling brain areas and a deficit in attention control (Pellicioni *et al.*, 2016). Thus, emotionality networks end up interfering with working memory, as shown in the study by Beilock *et al.* (2010). The authors suggest that MA leads to impairments in working memory, which could lead to a teacher explaining concepts superficially, struggling to explain a mathematical strategy or having difficulty demonstrating a problem on the board.

Studies such as Dowker *et al.* (2016), Ganley *et al.* (2019) and Hart and Ganley (2019) suggest factors that influence MA, such as genetics, gender, age, culture, nationality, as well as mathematical knowledge for teaching, traditional beliefs about teaching and learning mathematics, being an early elementary school teacher and lack of credentials for teaching mathematics.

Over the last decade, Brazilian research has shown the emergence of and interest in studying the phenomenon of MA among teachers or future teachers (Carmo and Simionato, 2012; Mendes and Carmo, 2014; França and Dorneles, 2021; Matos *et al.*, 2023; Oliveira and Silva, 2024). The subject is still emerging and few studies use the concept of MA to describe the relationship between educators and the subject. Furthermore, there is a lack of data on factors associated with MA among teachers in Brazil (França and Dorneles, 2021). The study by Matos *et al.* (2023) provides the first evidence in terms of academic research that deals with negative experiences in relation to mathematics as a possible factor with the potential to trigger or increase MA in teachers or future teachers of basic education. According to França and Dorneles (2021), there is a specific manifestation of MA in teachers in Brazil, i.e. anxiety when teaching mathematics, which still needs to be better studied, as most studies with teachers do not yet use the MA paradigm to describe this relationship with the subject, nor are the cognitive and pedagogical factors and impacts clear, nor how this specific manifestation relates to the affective-cognitive model.

To date, there has been no adapted or validated instrument in Brazilian research to check for symptoms of MA among the teacher population. It was therefore necessary for the researcher to carry out the process of Cross-Cultural Adaptation (CTA) of the American scale "*Math Anxiety Scale for Teachers* - MAST" to the Brazilian context, in order to better verify how MA manifests itself among teachers working in the early years of elementary school.

Studies claim that MA may be more prevalent among individuals who have some symptoms of Generalized Anxiety Disorder (GAD), since both share underlying cognitive mechanisms in relation to performance and physiological indicators such as palpitations, chills in the stomach, dizziness, paleness, tension headaches, etc (Adams, 2001). However, although similarities have been identified between Generalized Anxiety and MA, both from a physiological and neurofunctional point of view, the study conducted by Ray Hembree reported a moderate correlation of 0.35 between them (Hembree, 1990). The results of the studies by Hart and Ganley (2021) were also remarkably similar to those of Hembree (1990), finding a higher average correlation of MA with Generalized Anxiety of 0.44 (Hart and Ganley, 2021).

The aim of this study was therefore to identify factors associated with MA among elementary school teachers in the Pelotas/RS public school system.

LITERATURE REVIEW

Mathematics Anxiety (MA) is an important topic for research, whether in the field of psychology, health or education. In the mid-1990s Hadfield and McNeil (1994) pointed to three origins of MA: environmental (classroom issues, pressure to perform, cultural perceptions of mathematics), intellectual (innate factors, low aptitude for mathematics) and personality issues (resistance to exposing oneself to resolve doubts, low self-esteem) (Hadfield and McNeil, 1994). Studies cite the existence of potential factors that can influence the development of MA, such as gender, age, culture and ethnicity (Hembree, 1990; Beilock *et al.*, 2010; Dowker *et al.*, 2016; Ganley *et al.*, 2019; Hart and Ganley, 2019; Mendes and Carmo, 2014; França and Dorneles, 2021; Matos *et al.*, 2023). Establishing a relationship between teachers' MA and their performance is significant, since teachers who teach the subject should not feel anxiety about mathematics, especially in the early years.

Dowker *et al.* (2016) report on what we know about MA over the last 60 years. The authors discuss what MA is and how distinct it is from other forms of anxiety, comment on how it relates to attitudes towards mathematics, the association between MA and performance in mathematics, the ways in which MA is measured, and discuss some possible factors in MA, including gender, age and culture.

Among the published works on MA, it is exceptionally common to cite the study conducted by Ray Hembree (1990) as the key work on the descriptive nature of MA. The author used meta-analysis to characterize the nature of MA, including examining performance, attitude and other correlates of anxiety, describing overall levels of MA based on gender, grade, ability, specialization, race and ethnicity (Hembree, 1990).

Still on MA and its association with math performance, the meta-analysis studies by Zhang, Zhao and Kong (2019) and Barroso *et al.* (2021) also show a strong negative, statistically significant link between MA and math performance. This correlation was stronger in studies involving Asians, while it was weaker in European studies. In addition, this negative link was also stronger in studies within secondary education, while it was weaker in elementary school studies.

The research by Beilock *et al.* (2010) indicates that both men and women, in countries that offer equal education conditions for both sexes, showed little or no difference in mathematical performance. However, they indicate that when women evaluate themselves, they tend to express more MA. This increase in MA may come from a variety of sources, including exposure to gender stereotypes and the influence and social transmission of MA by female teachers, who are themselves anxious about mathematics (Beilock *et al.*, 2010).

In the study by Ganley *et al*. (2019), carried out with 399 elementary school teachers, the authors report the construct validation of the *Math Anxiety Scale for Teachers* - MAST. Factor analysis supports the distinction between the components of General Mathematics Anxiety (GMA) and Anxiety about Teaching Mathematics (AEM). MSA scores correlate with other teacher characteristics: higher MSA is associated with less mathematical knowledge for teaching, more traditional beliefs about teaching and learning mathematics, being an early elementary school teacher, and lack of specific credentials or training for teaching mathematics.

In another study, Hart and Ganley (2019) looked at the nature of MA in 1,000 North American adult English speakers. MA showed an approximately normal distribution, with a mean between fair and moderate. MA was negatively correlated with knowledge of probability and mathematical fluency, and positively correlated with general anxiety and test anxiety. The study also showed that: women reported higher MA than men, and that participants who had completed postgraduate studies or pursued STEM careers (which require skills in science, technology, engineering and mathematics subjects) had significantly lower levels of MA than those with less education or who did not have STEM careers. In this study we see evidence that AM in North American adults correlates with factors reported in previous studies of younger populations and students.

In Brazil, the qualitative research by Carmo and Simionato (2012) addresses MA as a multidetermined phenomenon, mainly in students. The authors state that one of the primary sources of MA is in the individual's school history with marked negative experiences, but point to other factors that can be identified, such as our Western culture that disseminates controversial information about mathematics, the use of coercive aversive control and finally the possibility that many teachers in the early grades of elementary school have MA.

Still on the subject of Western culture, Carmo and Simionato (2012) state that this controversial information in relation to mathematics ends up relating it to something difficult to grasp, accessible to a few individuals, requiring a lot of effort and dedication to master. Environmental factors also play a crucial role in the intensity of MA, such as the threat of stereotypes. Beliefs such as "math is difficult" or that "boys learn more math than girls" can reinforce a negative relationship with the subject. However, the context in school environments also needs to be considered as a possible influence on MA.

The study by Gomes (2021) looks at the dimensions of satisfaction/dissatisfaction with teachers in the early years working for the State Department of Education of the Federal District (SEEDF). In this study, professional satisfaction is defined as a positive and emotional state experienced at work, associated with important variables such as self-esteem, physical and mental well-being, appreciation, teacher motivation and professional fulfillment. The study found that teachers have aspects in which they are satisfied: autonomy, personal relationships, teaching activity and stability, while others cause them dissatisfaction, such as career plans and pay. However, although this feeling may appear at some point, it is possible to state that the level of satisfaction is considerably high in relation to the aspects linked to this profession (Gomes, 2021).

METHOD

The survey initially included 304 teachers, but after making some adjustments to the database, 19 teachers were excluded due to unanswered questions. In this way, 285

teachers took part, following the inclusion criteria of being from the Pelotas public school system and teaching mathematics in the early years of elementary school.

To collect the data, contact was made with the Pelotas Municipal Secretary of Education and Sport (SMED) and the 5th Regional Education Coordination (5ª Coordenadoria Regional de Educação RS - 5ª CRE), who provided a list with the addresses of the schools and the total number of teachers working in the early years (1,293 teachers, 993 from the municipal network and 300 from the state network) who were eligible to take part in the study. After this, the 81 schools were drawn, 40 of which were selected for the study. The researcher then contacted the schools to introduce the project to the principals and coordinators, as well as asking them to send the survey form to the teachers.

The teachers were invited to complete a self-administered *online* questionnaire on the Google Forms Platform, consisting of the Informed Consent Form (ICF), sociodemographic questions and the GAD-7 and MAST-BR instruments. Data was collected between May 2022 and March 2024.

INSTRUMENTS

***Generalized Anxiety Disorder-7* - GAD-7** - the Generalized Anxiety Disorder scale was used as a measure to assess anxiety. The instrument was developed by Spitzer (2006) and validated for Brazil by Moreno *et al.* in 2016. The scale consists of seven items, measured on a four-point *Likert-type* scale, ranging from "Not at all" (0 points) to "Almost every day" (3 points), with a total score ranging from 0 to 21 points, where the higher the score, the more anxious the symptoms. Participants are asked how often they feel bothered by the situations presented in the items, considering the last two weeks. Although the instrument has been validated for Portuguese, it does not have a defined cut-off point for Brazilian populations.

Math Anxiety **Scale** *for* **practicing teachers - MAST-BR** - The *Math Anxiety Scale for Teachers* (MAST) is a self-administered, self-administered instrument. Made up of fifteen statements, the scale aims to assess the level of MA in teachers. The instrument allows responses on a five-point *Likert* scale, ranging from 1 to 5*: (1) never true for me, (2) usually not true for me, (3) sometimes true for me, (4) usually true for me and (5) always true for me*, where the higher the score, the higher the level of MA (Ganley *et al*., 2019). Participants are asked how they react to situations involving math knowledge and teaching. The scores are calculated from the total sum and the sum by domain (AMG and AEM) (Ganley *et al.*, 2019). The scale was adapted to the Brazilian context by the researcher according to the article "*Psychometric Analysis and Validation of the Math Anxiety Scale for* Teachers/MAST-BR *for the Brazilian Context*", submitted and published in the *International Journal of Exact Sciences* in 2024. The adapted scale (MAST-BR) kept the same number of items (15) and the psychometric evidence was satisfactory, presenting a uni- and bi-dimensional model.

DATA ANALYSIS PROCEDURES

The information obtained from the data collection was entered into a *Statistical Package for* the *Social Sciences* - SPSS.25 database for descriptive, bi- and multivariate analysis . In order to achieve greater sample representativeness, the variables were recategorized into a dichotomous form.

The normality of the data was assessed using the *Kolmogorov-Smirnov* (K-S) and *Shapiro-Wilk* (S-W) statistical tests, considering that statistically significant results ($p < 0.05$) indicate normal distribution (Field, 2009). The results indicated that the variables "Math Anxiety - MAST-BR" (K-S (285) = 0.085, p<

0.001; S-W (285) = 0.955, p< 0.001), "Age" (K-S (285) = 0.55, p= 0.034; S-W (285) = 0.989, p= 0.029), "Length of service" (K-S (282) = 0.085, p< 0.001; S-W (282) = 0.957, p< 0.001) and "Generalized Anxiety - GAD-7" (K-S(285)= 0.122, p< 0.001; S-W (285) = 0.937, p< 0.001) do not show a normal distribution.

Given the non-normal distribution of the variables, the *Mann-Whitney* non-parametric tests were used to investigate the differences in means in the MAST-BR between groups. The effect size for non-parametric tests was analyzed ($r = z\sqrt{N}$), considering: very low (r< 0.2), low (r ≥ 0.2), medium ($r \geq 0.5$) and high ($r \geq 0.8$) (Field, 2009).

The statistical power of the sample was analyzed a posteriori using the G*Power *software* version 3.1.9.7. The sample power of the associations between math anxiety (measured by the MAST-BR) and gender, skin color, age, socioeconomic class, academic background, length of service, year/grade of service, network of service, job satisfaction, training for teaching mathematics, relationship with mathematics and its teaching and anxiety symptoms (measured by the GAD-7) were calculated using the Mann-Whitney test. The means and standard deviations of the MAST-BR according to each variable were used to compute Cohen's d. A significance level of 5% was considered for all analyses. 80% was considered acceptable power.

Spearman's non-parametric correlation was used to assess the association between MAST-BR scores and the following variables: age, length of service and GAD-7 scores. The results were analyzed considering the following categories (magnitudes): weak (r= 0.10-0.39); moderate (r= 0.40-0.69), strong (r= 0.70-0.89), very strong (r= 0.90-0.99) and perfect (r= 1.0) (Schober, Boer and Schwarte, 2018). The effect size (coefficient of determination) to investigate how much shared variance the variables have with each other was assessed using the square of the correlation coefficient (R^2) (Field, 2009).

A *chi-square* test was carried out to see if there was an association between the MAST-BR and GAD-7 classifications. To do this, in addition to the statistical significance (p-value), the Cramer's V value was observed to measure the effect size (Field, 2009), as well as the results of the adjusted residuals - with values >2 expected to indicate the significance of the association by category.

A multiple linear regression analysis was carried out to investigate which variables were predictors of MAST-BR scores. Thus, those variables that showed a statistically significant difference in MAST-BR scores were included in the model, using the *Mann-Whitney* tests. The statistical significance of the model (p-value), the adjusted R^2value, as well as the values of the standardized beta coefficient (β) and the statistical significance of each variable (p-value) were observed.

The rules for interpreting the MAST-BR scores were proposed based on quartiles/ percentiles, as have other authors in the literature (Zanon, Bardagi, Layous and Hutz, 2014; Silva, Leite, Feitosa and Faro, 2023). For the qualitative interpretation of the scores, quartiles were used, defining them increasingly according to the degree/intensity of presentation of math anxiety symptoms.

RESULTS AND DISCUSSION

A total of 285 teachers took part in the study. The majority were female (97%), white (80%), aged between 24 and 67 (M= 45.78; SD= 9.16) and belonging to socioeconomic classes D and E (65%). The majority worked in the literacy cycle, i.e. up to the 3rd year of the initial years of elementary school (69%), in the municipal school system (68%) and with a length of service between beginners (less than a year) and 44 years (M= 14.1; SD= 9.86).

With regard to academic training, the majority of teachers indicated that they had a postgraduate degree (71%). However, almost all of the participants said that they had not had any specific training in teaching mathematics (91%). The teachers expressed professional satisfaction (60%) and most of them considered that they had a good/optimal relationship with mathematics and its teaching (85%). It was also observed that 12% of the teachers in the state network indicated that they had taken training courses in teaching mathematics, while in the municipal network only 8% had done so. The data is shown in Table 1.

To assess the presence of anxiety symptoms, the GAD-7 scores were dichotomized, considering a cut-off point ≥ 10 (moderate and severe) (Silva, Leite, Feitosa and Faro, 2023). As a result, 20% of the teachers were found to have anxiety symptoms.

Still in relation to Table 1, regarding the differences in means, the results of the *Mann-Whitney* tests did not indicate statistically significant differences in the MAST-BR scores between the sexes (U= 890.0; z= -1.896; p= 0.058; r= 0.11), between whites and non-whites (U= 6328.0; z= -0.456; p= 0.649; r= 0.03), between those aged less than 46 and over (U= 10002.0; z= -0.209; p= 0.835; r= 0.05), between upper-middle and lower-middle socioeconomic classes (U= 8944.0; z= -0.250; p= 0.803; r= 0.01), between those who said they had only completed an undergraduate degree and those with a postgraduate degree (U= 7774.0; z= -0.748; p= 0.454; r= 0.04), among those with more than 10 years' experience in teaching or less (U= 9323.5; z= -0.376; p= 0.707; r= 0.02) and among those who worked in the literacy cycle in the initial years or after (U= 7735.0; z= -1.309; p= 0.191; r= 0.08). Thus, the data suggest that math anxiety does not seem to be related to gender, skin color, age, social class, level of academic training, length of time in the teaching profession or the grade/year in which the teacher works. Furthermore, the effect size of these comparisons was tiny (r≤ 0.08). These associations should be better investigated since in this study the sample size of these variables had no statistical power, as shown in Table 2.

On the other hand, there were statistically significant differences in the MAST-BR scores between the groups related to the network in which they work (U= 6946.0; z= -2.972; p= 0.003; r= 0.18), professional satisfaction (U= 7527.5; z= -3.190; p= 0.001; r= 0.19), training for teaching mathematics (U= 2081.5; z= -3.401; p= 0.001; r= 0.20), relationship with mathematics and its teaching (U= 2500.0; z= -5.577; p= 0.000; r= 0.33) and the presence of anxiety symptoms, according to the GAD-7 scale (U= 4610.5; z= -3.261; p= 0.001; r= 0.19). Thus, it is understood that teachers who were working in the municipal school system, who declared that they were dissatisfied with teaching, who had not had specific training in teaching mathematics, who had a very poor/regular relationship with mathematics and its teaching and who had anxious symptoms (GAD-7) showed significantly higher AM scores (MAST-BR). In these comparisons, it was found that, in general, the effect size fluctuated between low and very low (r≤ 0.33), suggesting little variance between the groups' scores.

The sample power ranged from 7.9% to 99.9%, revealing that the sample size was not adequate for the variables that were not associated with math anxiety (MAST-BR). Table 2 shows the sample power for each variable, as well as the effect size used for the calculation.

Spearman's non-parametric correlation showed that age was not associated with MA (MAST-BR scores) (r= 0.032; p= 0.587) or with length of professional career (r= 0.021;

	N (%)	MAST-BR (M; SD)	Median	Mean Rank	p-value
Biological sex					p=0,058
Female	275 (97)	32,6 (12,65)	31,0	144,76	
Male	10 (3)	25,1 (8,93)	23,5	94,50	
Skin color					p=0,649
White	227 (80)	32,19 (12,65)	30,0	141,88	
Non-white	58 (20)	32,90 (12,51)	32,0	147,40	
Age					p=0,835
Up to 45 years	146 (51)	32,51 (13,39)	30,0	142,01	
46 years or older	139 (49)	32,15 (11,76)	32,0	144,04	
Socioeconomic class (N=283)					p=0,803
Medium-high (A+B+C)	99 (35)	32,72 (13,23)	31,0	143,66	
Medium-low (D+E)	184 (65)	31,99 (12,21)	30,0	141,11	
Academic background (N=283)					p=0,454
Undergraduate	82 (29)	33,63 (13,56)	30,0	147,70	
Postgraduate	201 (71)	31,83 (12,24)	31,0	139,68	
Length of service (N=282)					p=0,707
Up to 10 years	114 (40)	32,16 (13,08)	31,0	139,29	
11 years or more	168 (60)	32,60 (12,35)	31,0	143,00	
Year/grade of performance (N=284)					p=0,191
Literacy cycle (1st, 2nd and 3rd grade)	197 (69)	32,99 (12,48)	31,0	146,74	
4th and 5th grades	87 (31)	31,05 (12,76)	29,0	132,91	
Network					p=0,003
Municipal	193 (68)	33,80 (12,56)	33,0	153,01	
State	92 (32)	29,26 (12,19)	28,0	122,00	
Professional satisfaction (N=284)					p=0,001
Dissatisfied	114 (40)	35,46 (13,14)	33,0	161,47	
Satisfied	170 (60)	30,30 (11,83)	29,0	129,78	
Mathematics teaching training (N=283)					p=0,001
No	256 (90,5)	33,18 (12,47)	32,0	147,37	
Yes	27 (9,5)	25,04 (11,69)	20,0	91,09	
Relationship with mathematics and its teaching					p=0,001
Poor/Regular	44 (15)	42,95 (13,02)	44,0	206,68	
Good/Optimal	241 (85)	30,39 (11,53)	29,0	131,37	
Anxious symptoms					p=0,001
No (GAD-7 < 10)	229 (80,4)	30,98 (11,80)	30,0	135,13	
Yes (GAD-7 ≥ 10)	56 (19,6)	37,88 (14,27)	36,5	175,17	

Legend: N= sample size; %= percentage; M= mean; SD= standard deviation.

Table 1: Characterization of participants and differences in mean scores for Mathematics Anxiety (MAST-BR) (N=285)

p= 0.721). On the other hand, a statistically significant correlation was identified between the MAST-BR and GAD-7 scores (*r*= 0.407; *p*= 0.000), as shown in Table 3. This correlation was moderate (Schober, Boer and Schwarte, 2018), providing evidence for the convergent validity of the MAST-BR scale, since the constructs are similar but differ in their specificities. This correlation was positive, significant and of the expected magnitude, suggesting that the higher the scores for MA (MAST-BR), the higher the scores for generalized anxiety (GAD-7). The effect size of the correlation between MAST-BR and GAD-7 scores indicates that there is 16.5% shared variance between these variables.

A *chi-square* test (2x2) was carried out to verify the association between the MAST-BR results - considering the cut-off point of 31, established at the 50th quartile - and the presence or absence of anxiety symptoms (GAD-7), as shown in Table 4. The results indicated that the association was statistically significant ($\chi 2$ (1) = 6.737; p= 0.09; Cramer's V=0.154). Thus, it was found that those who were indicated as symptomatic on the MAST-BR were 2.22 times more likely to be classified as anxious on the GAD-7.

The results of the logistic regression analysis indicated a significant influence ($F(5, 276) = 15.44$; $p= 0.000$; $R^{(2)}_{(adjusted)}= 0.204$) of the predictor variables (Network, Professional Satisfaction, Specific Training for Teaching Mathematics, Relationship with Mathematics and its Teaching and GAD-7) on the MA (MAST-BR). Thus, it was observed that the five variables explained 20% of the results in MAST-BR. Looking at the values of the standardized coefficients (β), it was found that the variable "relationship with mathematics and its teaching" was the one that had the greatest impact on the MAST-BR scores ($\beta=0.334$; $p=0.000$) and the only one that did not significantly influence the MAST-BR results was the variable "job satisfaction" ($\beta=0.099$; $p=0.075$).

Predictors	B	t	p
(constant)	-	11,663	0,000
Net	-0,121	-2,256	0,025
Satisfaction	-0,099	-1,787	0,075
Training	-0,133	-2,465	0,014
Relationship	-0,334	-6,216	0,000
GAD-7	0,163	2,996	0,003

Table 5: Math anxiety predictor variables (MAST-BR scores)

To enable screening based on the MAST-BR scale, the interpretation standards (Table 6) were drawn up based on the distribution of the total score, transformed into percentiles and quartiles. For the qualitative interpretation, the quartiles were taken into account. The average MAST-BR score for the total sample was 32.33 (SD= 12.60). Considering the two-dimensional model of the MAST-BR, the mean for the General Mathematics Anxiety (GMA) dimension, made up of the first nine items, was 18.51 (SD=7.47) and for the Anxiety about Teaching Mathematics (AEM) factor, made up of the remaining six items (items 10-15), it was 13.83 (SD=6.07). Table 6 shows the sample scores stratified by quartiles and percentiles, as well as the corresponding qualitative interpretation.

As for the profile of the sample, in relation to the variables gender and skin color, the data resulting from our study are in line with the study by Ganley *et al.* (2019) which found a predominance of female teachers (95%) of white skin color (81%). Statistics from the National Institute of Educational Studies and Research Anisio Teixeira (INEP) corroborate the current research, which reports that basic education is predominantly female, with 96.3% in early childhood education, 88.1% in the initial years and 66.5% in the final years of elementary school (INEP - School Census, 2021).

Variable	Cohen's d	Sampling Power
Gender	0,68	66,6%
Skin color	0,06	10,2%
Age	0,03	7,9%
Socio-economic class	0,06	11,6%
Academic background	0,06	11,8%
Length of service	0,03	8,6%
Year/grade of performance	0,15	31,5%
Network	0,37	88,0%
Professional satisfaction	0,41	95,3%
Training for teaching mathematics	0,67	94,5%
Relationship with mathematics and its teaching	1,02	99,9%
Anxiety symptoms	0,53	96,4%

Table 2: Description of the effect size when comparing the means and sample power of the descriptive variables.

	MAST-BR scores	R^2
Age	0,032 (p= 0,587)	0,000
Length of service	0,021 (p= 0,721)	0,000
GAD-7	0,407 (p= 0,000)	0,165

Legend: R^2 = coefficient of determination (effect size).

Table 3: *Spearman* correlations with MAST-BR scale scores

	MASTBR result		
GAD-7 result	**Without math anxiety symptoms**	**With math anxiety symptoms**	**Total**
Without anxiety symptoms	122	107	229
With anxious symptoms	19	37	56
Total	141	144	285

Table 4: Association between MAST-BR and GAD-7 scores among teachers (N=285)

	MAST-BR		AMG	MSA
N	285			
Average	32,33		18,51	13,83
Standard deviation	12,60		7,47	6,07
Median	31,0		17,0	13,0
Minimum	15		9,0	6,0
Maximum	72		42,0	30,0
Percentiles				
10	16,6	Low (24%)	9,0	6,0
20	20,0		11,0	8,0
25	22,0	Medium-Low (26%)	12,5	9,0
30	24,0		13,0	10,0
40	28,0		15,4	12,0
50	31,0	Medium-High (23%)	17,0	13,0
60	33,6		19,0	15,0
70	38,0		22,0	16,2
75	40,0	High (27%)	24,0	18,0
80	44,0		26,0	18,0
90	50,0		29,0	23,0

Legend: N= sample size; AMG= General Mathematics Anxiety; AEM= Mathematics Teaching Anxiety. **Table 6**: Suggested interpretation standards for the MAST-BR Scale for the Unidimensional Model (15 items) and Bidimensional Model (09 items in AMG and 06 items in AEM)

With regard to job satisfaction, the study by Gomes (2021) showed that 54.4% of primary school teachers are satisfied with aspects such as autonomy, personal relationships, teaching activity and stability, while other aspects cause them dissatisfaction, such as career plans and pay. Although this feeling may appear at some point, it was observed that the general level of satisfaction is considerably high in relation to the aspects linked to this profession. This corroborates our study, where more than half of the teachers (60%) said they were satisfied with their profession, although the professional satisfaction variable was considered in general. Thus, teacher satisfaction is relevant to the productivity, physical and mental well-being of teachers who work daily with students who need their dedication, motivation and commitment. Satisfaction depends not only on intrinsic factors such as feelings, emotions and experiences, but also on extrinsic factors such as working conditions, recognition, opportunities, etc.

As for length of service in teaching, the study by Ganley *et al.* (2019) found a shorter average time (11.4 years), while Gomes (2021) reports in his research that 41.4% of teachers are beginners, i.e. they have been teaching for between 0 and 5 years. It is therefore possible that the teachers in our study have more experience due to their longer service in teaching.

When it comes to the network of operation variable, the predominance of teachers in the municipal education network can be understood not only by the fact that this body has the legal responsibility for offering education in the initial and final years of

primary education, but also because it has the largest number of teachers (993), while the state network, although it can offer primary education, only has the legal responsibility for offering secondary education, in addition to having a smaller number of teachers in the initial years (300).

Studies cite the existence of potential factors that can influence the development of MB, such as gender, age, culture and ethnicity (Hembree, 1990; Beilock *et al*., 2010; Dowker *et al*., 2016; Ganley *et al*., 2019; Hart and Ganley, 2019; Mendes and Carmo, 2014; França and Dorneles, 2021; Matos *et al.*, 2023). According to Dowker *et al*. (2016), gender is the factor that has been studied most in relation to MB. Most studies suggest that these gender differences only develop during adolescence. Studies indicate that men and women, in countries that offer the same educational conditions for both sexes, have shown little or no difference (Dowker *et al*., 2016; Beilock *et al*., 2010; Barroso *et al*., 2021). However, according to Ganley *et al*. (2019), when women self-assess, they tend to identify more MA. In addition, higher levels of MA can be explained by the fact that women represent more than 90% of the elementary school workforce (Ganley *et al.*, 2019). The MA identified in women can come from several sources, including exposure to gender stereotypes, culture and the influence and social transmission of MA by female teachers who are themselves anxious about mathematics (Beilock *et al*., 2010). Still referring to the gender factor, Hart and Ganley (2019) showed that in the general adult population, women report higher MA than men.

In the present study, no association was found between age and MA scores. On the other hand, Dowker *et al*. (2016) state that MA seems to increase with age, one possible reason being that general anxiety seems to increase with age throughout childhood and adolescence. This increase may come from the awareness of social comparison that is leading to the increase in general anxiety and MA. Reasons related to mathematics may include exposure to other people's negative attitudes towards mathematics, social stereotypes about the general difficulty of mathematics or about supposed gender differences, experiences of failure or threats thereof, and changes in the content of mathematics itself (Ganley *et al*., 2019).

The factors specific training for teaching mathematics and the teacher's academic background are predictors of lower MA. They confirm the idea that teachers who are better prepared become more confident and show fewer symptoms of MA, due to the skills developed in the courses. According to the literature, the study by Ganley *et al*. (2019) found that teachers with specific teaching certification in mathematics (2.8%) had lower levels of MA than those without certification. The authors state that few teachers have a solid educational background in mathematics, with less than 5% of elementary school teachers in the United States having a degree in mathematics and less than 2% being certified to teach mathematics (Ganley *et al*., 2019).

With regard to teachers' relationship with mathematics and its teaching, the association found in this study - a higher MA score in teachers who defined their relationship with mathematics as poor/regular, can be explained by Dowker *et al*. (2016). The authors, when studying teachers' relationship with mathematics, despite not having a formed concept, came up with the possible reason that it is related to the amount of skill and mastery that the teacher has with the mathematical content. Also according to the authors, teachers who have a very poor relationship with mathematics and have high MA scores prefer to work in the first grades (early years), so as not to deal with more complex

International Journal of Biological and Natural Sciences ISSN 2675-5157 DOI https://doi.org/10.22533/at.ed.5157125230073

mathematical content at higher elementary levels, because they don't believe in their abilities in these contexts. An association was found between MA (MAST-BR) and anxiety symptoms (GAD-7), in line with studies by Hart and Ganley (2021) and Hembree (1990), who also found an association between these variables (0.44 and 0.35, respectively).

Despite the results of this study, some limitations were encountered during the course, such as the initial sample size for calculating prevalence which was not obtained, the selection of the sample for convenience, the evaluation of the variable professional satisfaction with teaching by means of self-report, without specifying the motivating sources and the form of data collection which led to poor adherence by the participants which impaired the statistical power of some analyses.

CONCLUSION

MA is an emotion that should be considered in the effectiveness of teaching practice. This study presents evidence on the profile of teachers working in the early years of elementary school in the city of Pelotas, RS, as well as the association and significant influence of the predictor variables Network of Practice, Professional Satisfaction, Specific Training for Teaching Mathematics, Relationship with Mathematics and its Teaching and Generalized Anxiety (GAD-7) on MA (MAST-BR). It was concluded that the most predictive factors for MA were the subjective perception of the teachers' relationship with the subject of mathematics and its teaching and the presence of symptoms of generalized anxiety.

The article also provided a way of interpreting the MAST-BR scores using quartiles. This proposal could help to use the scale in different contexts to identify teachers' level of anxiety when it comes to teaching mathematics. More studies like this could help to build strategies to prevent MA and provide mental health support to teachers within schools. Interventions in this area that can be carried out as part of an action plan aimed at improving teachers' performance in relation to mathematics and its teaching.

We suggest further research investigating ML in teachers who work at other levels of education, as well as the extent to which specific training can minimize ML among these professionals. Research into MA and the training of teachers who teach the subject, especially in Pedagogy courses, is still little explored in Brazil. The academic and continuing training of teachers who teach mathematics in Brazilian education and its relationship with ML is a prominent research topic in the field of mathematics education, psychology and neuroscience, given its relevance.

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NOTAS DO AUTOR

Para acessar a escala MAST-BR, basta clicar no seguinte link: https://tinyurl.com/EMASTBR