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DIMENSIONS OF MATH ANXIETY AMONG PRIMARY SCHOOL-AGE ROMANIAN CHILDREN

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Abstract

Math anxiety has recently become a focus in educational psychology and math teaching. Math anxiety refers to feelings of tension and worries that interfere with performance in daily life and school settings. Math anxiety in primary school-age children indicates that its onset can be placed in early years of schooling. Despite the interest in this topic, few studies have begun to investigate math anxiety in young children. In Romania, relatively scarce attention has been paid to the math anxiety among primary school-age children. This study explores math anxiety in a sample of 137 fourth-grade Romanian students (63 boys and 74 girls). We explore how math anxiety relates to math achievement. We also explore gender differences in math anxiety. Math Anxiety Questionnaire (MAQ; Wigfield & Meece, 1988) was used for data collection. The MAQ includes items designed to measure possible cognitive and affective components of math anxiety. Students' concern about not lagging behind their peers when they were absent from school, as well as their fears about math tests were prevalent in the representation of math anxiety symptoms. Comparative data revealed no significant differences between boys and girls in terms of their MAQ scores. Students with higher math achievement reported lower degrees of negative affective reactions and of worry related to math study. The association between the affective dimension of math anxiety and math achievement was stronger than the association between the cognitive dimension and math achievement. The authors conclude with a discussion of several factors to be kept in mind when working with math-anxious students.

Key words*:* Correlational data; gender-based comparisons; math achievement; math anxiety; primary school-age children

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1. Introduction

Mathematics is one of the most complex subjects of study, which students from all parts of the world must cover at least when engaged on the compulsory educational route. Specialists in the fields of developmental psychology, education psychology and professionals who deal with the teaching and learning of mathematics unanimously acknowledge that the study of this discipline contributes to the ordering and progress of logical-abstract thinking. These acquisitions are materialized in the capacity of inductive and hypothetical-deductive, concrete and symbolic reasoning, as well as in the elaboration and / or application of algorithmic and heuristic strategies, in order to solve the different categories of exercises and problems known in the field of mathematics. The curricular contents of mathematics are varied and involve the gradual acquisition of sets of theoretical and practical knowledge that are systemically organized. In addition, in almost all countries of the world, mathematics is a core discipline in which students of different ages are evaluated periodically, including at the end of important stages of the educational path. For these reasons, the study of mathematics can be a challenge both for students and their parents, as well as for teachers who teach this discipline.

The specialists in the field of educational psychology have noted significant individual differences both in the performance of students of all ages in mathematics and in the perceptions, beliefs, attitudes and beliefs that students have in relation to the study of mathematics. One of the directions of the studies concerned the factors that explain the differences found. In the last five decades, the attention of studies has turned to math anxiety.

Research on math anxiety and performance in this area has examined the relationships between this debilitating psychological condition and: a) affective variables (for example, generalized anxiety, anxiety as a behavioral predisposition or that manifests itself in the evaluation of their own school performance) b) performance in school assignments (for example, results in mathematics acquisition tests, grades in this study discipline or results in national exams); c) motivational factors (for example, the intention to take additional mathematics courses or high school specializations in which general mathematics or its various fields of application represent core subjects). The interest in investigating math anxiety has also been stimulated by the fact that, in many countries, curriculum reform for this discipline attaches much greater importance to the cognitive and emotional experiences that students of different ages are experiencing in the process of learning mathematics and its application areas.

2. Theoretical framework

Since the 1960s, a very large body of studies and scientific articles have accumulated, which have focused on math anxiety. One of the researchers' concerns was to define this psychological condition with multiple educational implications. Thus, F. C. Richardson and R. M. Suinn (1972) defined this domain through a set of negative cognitions and emotions in which tension, apprehension and fear predominate. These interfere with work tasks in which numbers are manipulated or in which mathematical problems need to be solved in a variety of situations in daily life or in the context of school / academic activities. X. Luo, F. Wang and Z. Luo (2009) provide a general picture of math anxiety described through negative cognitions, dysfunctional emotional dispositions, and counterproductive behavioral responses that occur when students encounter math problems. Some of the students show an excessive level of math anxiety, expressed through panic, nervousness and fear, depression and a feeling of helplessness. These negative cognitive and emotional states are accompanied by certain physiological reactions, such as heavy sweating, trembling of hands, clenching of fists, vomiting, dry sensation of lips, facial pallor, frequent sensation of urination, intermittent headaches, etc. Anxious students experience the feeling that their own efforts to learn mathematics are threatened, which in time leads to the loss of interest in mathematics and confidence in their own strengths in this area.

Many researchers conceptualize math anxiety as a form of specific manifestation of test anxiety. This orientation is based on the results of the studies according to which models that explain the causes of anxiety about testing can also be applied to math anxiety (Hembree, 1990). Another aspect that allows the connection between math anxiety and test anxiety concerns the dimensions in which the two fields are organized (Liebert & Morris, 1967; Wigfield & Meece, 1988). These include an *affective (emotional) component* - nervousness, tension, anticipatory apprehension, fear, accompanied by unpleasant physiological reactions and a *cognitive component* - negative expectations about performance, rumination of one's abilities or assessment of the situation when anxiety is manifested. However, a study by Kazelskis and colleagues (2000) suggests that math anxiety is a phenomenon closely related to test anxiety and exam anxiety in general, although the two areas have a degree of separation.

Findings from empirical studies, including meta-analyzes, converge to highlight the debilitating effects that math anxiety has on mathematics acquisition and performance (Ashcraft & Moore, 2009; Hembree, 1990; Hopko et al., 2003; Luo, Wang, & Luo, 2009; Ma, 1999; Vucovic et al., 2013). Compared to male students, female students tend to report significantly higher levels of counterproductive cognition (e.g., worry) and negative emotions related to mathematics and performance in this field (Hembree, 1990; Ho et al., 2000; Lafferty, 1996; Luo, Wang, & Luo, 2009; Yüksel-Şahin, 2008). The differences mainly concern the cognitive component of math anxiety in relation to mathematics (Wigfield & Meece, 1988).

One drawback of the studies that focused on gender or age differences in math anxiety in the school population is that very few researchers were interested in this issue among primary school-age children (Gierl & Bisanz, 1995; Supekar et al., 2015; Vukovic et al., 2013). In a complex study performed by R. K. Vukovic and colleagues (2013), a longitudinal design was used to explore the relationship between math anxiety and different types of math performance (performance in mathematical calculus, algebra or geometry). The effects of general reading ability and numbering were verified. The authors also sought to verify whether the relationship between math anxiety and performance indicators in this area differs depending on the capacity of visual-spatial working memory. Participants in the study were 113 second-grade students (from two schools located in a US urban center). They were tracked until the third grade. The results of the hierarchical multiple regression analyses showed that math anxiety was a unique source for individual differences regarding the performances that the children obtained in the tasks of arithmetic calculation and in the specific mathematical applications. Longitudinal data showed that, for children with a high level of visual-spatial working memory, high levels of math anxiety (measured in grade II) were predictors of a more modest level in terms of developing the ability to work with specific mathematical applications. This remarkable study suggests that math anxiety is an important factor that conditions performance in mathematics among young school-age children. Another conclusion of the study is that math anxiety can influence how children use working memory to learn various specific applications.

3. The current study

In the Romanian education system, the primary cycle represents a very important stage in which the first bases of the knowledge in the field of mathematics are laid. At the end of this period, the students of the fourth class pass through the national test which aims to evaluate the level of basic acquisitions in Romanian and Mathematics. Therefore, investigating the dimensions of math anxiety, the factors associated with this unpleasant experience faced by some of the students of young school age and the impact that math anxiety has on the school results gain psycho-pedagogical relevance. This study responds to this objective.

3.1. Aim

Knowing the factors associated with math anxiety among primary school-age children is a very important step in designing and implementing the psycho-pedagogical measures that are needed to improve this debilitating psychoeducational condition and math performance. In our approach, we aim to highlight the dimensions of anxiety regarding mathematics among fourth-grade students and the variables associated with this psychological condition that can negatively impact student performance.

3.2. Hypotheses

The working hypotheses were:

H1. Compared to boys, girls show significantly higher levels of negative emotions, worries, as well as global math anxiety.

H2. The levels of negative emotions, anxiety and global math anxiety are associated with the performance that fourth grade students achieve in mathematics.

3.3. Variables and design

The main independent variable was the gender of the students, and the dependent variables were the scores for the dimensions of math anxiety and the performance that the students of the fourth grade obtain in mathematics. This quantitative study was based on a mixed design, i.e. cross-sectional and correlational.

4. Method

4.1. Participants

The raw data were obtained by processing the answers that 137 students of the fourth grade gave to a protocol that included two standardized questionnaires. There were 63 boys and 74 girls. At the time of administering the questionnaires, participants ranged in age from 9 to 11 years (M = 10.15; *SD* = 0.46).

4.2. Measures

The standardized protocol administered to primary school students included two accessible questionnaires regarding item intelligibility. The first questionnaire asked the students to indicate the first and last name, sex, age, indicative of the class they belonged to, respectively the school in which they were studying.

The second questionnaire was the Romanian version for the *Math Anxiety Questionnaire*

(MAQ). This instrument was constructed and standardized psychometrically by A. Wigfield and J. L. Meece (1988). Initial validation studies were conducted in the population of middle school and high school students in the US. The version we used in this study included 11 items. For each item, students responded on scales that included four verbal anchors. For most items, they were different. For example, to answer the item “In general, how much do you worry about how well you are doing in math?”, the students had to choose between four variants, namely: I do not worry at all, I worry a little, I worry quite a lot, I get very worried.

The elements of the MAQ instrument are the result of successive qualitative and psychometric approaches that began in the early 1980s. In a longitudinal study aimed at assessing the beliefs and attitudes that middle school students and high school students in the US have towards mathematics, Wigfield and Meece administered to a sample of 564 subjects a version of the MAQ instrument that included 11 items. The content of the items focused on the negative affective reactions to the classes of mathematics, respectively on the concerns that the students had regarding the performance in this discipline of study. The two dimensions are based on the study by R. M. Liebert and L. W. Morris (1967) that have empirically described and identified two components of anxiety that students of all ages can experience in various situations in which school acquisitions are evaluated. These are: a) *emotionality* - the negative emotional reactions (and the unpleasant neuro-vegetative symptoms associated with them) that occur before, during or after facing an evaluation situation; b) *worry* - cognitive ruminations regarding the possible failure, which interferes with the subject's efforts to focus on solving tasks. Negative cognitions about failure are also based on the performance that the student has achieved in the past. The anxious subject does not trust his own competences, thinks that others are much better prepared than him and tends to perceive himself as more vulnerable than others to failure. These aspects of anxiety negatively interfere with the cognitive activity required to solve tasks, weakening the processes specific to the updating of information and those involved in regulating attention. Although, from the psychometric (factorial) point of view, there are separate facets of anxiety that manifest in assessment situations, cognitive concerns and negative emotional reactions correlate with each other. However, the two dimensions can be distinguished by the fact that the score for *worry* correlates more strongly with the school performance than the score for *emotionality* (Liebert & Morris, 1967).

In the study published by Wigfield and Meece (1988), the results of exploratory and confirmatory factor analyses revealed two latent dimensions in which the responses to items in the MAQ are grouped, namely: a) negative affective reactions to mathematics (which we called *negative emotions*) - items 1, 2, 4, 5, 6, 9 and 11 (see Table 1) and b) the cognitive concerns that the students have regarding the success in mathematics (which we called *worry*) - items 3, 7, 8 and 10. Wigfield and Meece reported a moderate value of the correlation between the two dimensions. This result signifies an acceptable level of clarity of the two dimensions from a conceptual and psychometric point of view.

Table 1: MAQ items used in the current study

Original English version of the MAQ	**Adapted Romanian version of the MAQ**
1. I dread having to math (*I never feel this way...I very often feel this way*)	1. Te gândeşti cu groază la ideea că, la şcoală, trebuie să faci în continuare matematică (*nu, nu mă gândesc niciodată...mă gândesc tot timpul*)
2. When the teacher says he/she is going to ask you some questions to find out how much you know about math, how much do you worry that you will do poorly? (*not at all...very much*)	2. Când învățătorul/învățătoarea îți spune că urmează să-ţi pună câteva întrebări, pentru a vedea ce anume ştii la lecţia de matematică la care aţi ajuns, cât de tare începi să te emoţionezi la gândul că nu vei şti să răspunzi corect ? (*nu mă emoționez deloc...mă emoționez foarte tare*)
3. In general, how much do you worry about how well you are doing in math? (*not at all...very much*)	3. În general, cât de mult îţi faci griji despre cât de bine te descurci la matematică ? (*nu-mi fac griji deloc…îmi fac foarte multe griji*)
4. When I am in math, I usually feel (*not at all at ease and relaxed...very much at ease and relaxed*)	4. În timpul orelor de matematică, de obicei te simţi (*foarte speriat/-ă…foarte liniștit/-ă și relaxat/-ă*)
5. When I am taking math tests, I usually feel (*not at all nervous and uneasy...very nervous and uneasy*)	5. Când vorbeşti despre testele pe care le ai de dat la matematică, de obicei te simţi (*foarte speriat/-ă…foarte liniștit/-ă și relaxat/-ă*)
6. It scares me to think that I will be taking advanced high school math (*not at all...very much*)	6. Te sperie gândul că, la şcoală, urmează să treci la lecţii de matematică din ce în ce mai grele (*nu, deloc…foarte mult*)
7. If you were absent from school and you miss a math assignment, how much do you worry that you will be behind the other students when you come back to school? (*not at all...very much*)	7. Când absentezi de la şcoală şi pierzi o lecţie la matematică, cât de mult îţi faci griji că vei rămâne în urmă faţă de colegi la matematică ? *nu-mi fac griji deloc…îmi fac foarte multe griji*
8. Compared to other subjects, how much do you worry about how well you are doing in math? (*much less than other subjects...much more than other subjects*)	8. Când te gândeşti la calificativele pe care le obţii la alte discipline, cât de mult îţi faci griji despre cât de bine te descurci la matematică ? (*îmi fac griji foarte puțin la matematică, în comparație cu alte discipline…îmi fac griji foarte mult la matematică, în comparație cu alte discipline*)
9. Taking math tests scares me (*I never feel this way...I very often feel this way*)	9. Te simţi speriat(ă) în timpul testelor pe care le dai la matematică ? (*nu, nu mă simt speriat/-ă niciodată…mă simt speriat/-ă întotdeauna*)
10. In general, how much do you worry about how well you are doing in school? (*not at*	10. În general (nu doar la matematică), cât de mult îţi faci griji despre cât de bine te descurci la

all...very much)	diverse discipline pe care le studiezi la şcoală ? (*nu-mi fac griji deloc…îmi fac foarte multe griji*)
11. When the teacher is showing during the class how to do a problem, how much do you worry that other students might understand the problem better than you? (*not at all...very much*)	11. Când învăţătorul/învăţătoarea vă arată în clasă cum se rezolvă un exerciţiu sau o problemă de matematică, cât de mult te emoţionezi la gândul că ceilalţi elevi din clasă ar putea să înţeleagă rezolvarea exerciţiului sau a problemei mai bine decât tine ? (*nu mă emoționez deloc...mă emoționez foarte tare*)

Note: For the original English version of the MAQ, scales for each item ranged from 1 to 7. For adapted Romanian version of the MAQ, possible responses for each item ranged from 1 to 4.

To carry out the present study, the original version (in English) of the MAQ was translated into Romanian. In this approach, special attention was paid to the formulations of the items in Romanian, so that: a) the translation does not distort the meaning of the items from the original version and b) the equivalents in Romanian are accessible to the comprehension and reading ability of fourth-grade students. For the original version that Wigfield and Meece tested, each item was assigned a seven-levels verbally anchored scale. In our study, each item was assigned only four answer variants, to facilitate the activity of completing the questionnaire by the fourth-grade students.

4.3. Procedure

The students were recruited through a convenience sampling strategy from eight public schools located in the urban and rural area of the region of Moldavia. The questionnaires were administered during the regular school program. Responses were collected from 145 fourth-grade students, but in the final database, protocols were retained for only 137 students. The rest of the students were eliminated during the validation phase of the answers to the standardized questionnaires.

The students indicated their first and last name, because, at the end of the first semester of the 2018-2019 school year, the math grades were collected. The centralization of the results highlighted the preponderance of the students who had obtained the grade *very well* (46.7%) or *well* (35.8%). The rest of the students obtained the *sufficient* grade.

4.4. Statistical analyses

Raw data were processed using SPSS for Windows 20.00 (IBM SPSS, Chicago, IL) and AMOS 20.00 (Arbuckle, 2011). Using confirmatory factor analysis with AMOS, two hypothetical measurement models of the MAQ were investigated and compared to each other: a) a one-factor model in which MAQ items were hypothesized to indicate a single latent construct (i.e., *math anxiety*); b) a model that included two latent factors (i.e., *negative emotions* and *worry*) which were allowed to correlate freely between them; within this model, scores on the items meant to capture each dimension of math anxiety were introduced as indicators for the corresponding latent factors. In order to estimate parameters of each measurement model, maximum likelihood (ML) method based on variance-covariance matrix input was used, as other authors have used it when the condition of data normality is not met (Savalei, 2008). The statistical adequacy of hypothetical measurement models was estimated using the following criteria (Byrne, 2010; Schermelleh-Engel, Moosbrugger, & Müller, 2003): χ^2 (Fisher's chi-square exact test), degree of freedom (*df*) and statistical significance level (*p*), χ^2/df, goodness-of-fit index (GFI), comparative fit index (CFI), and root mean square error of approximation (RMSEA) with the 90% confidence interval. Taking into account the suggested landmarks from literature, a measurement model was considered as showing a good statistical fit when: a) χ^2 is not statistically significant ($p > 0.05$); b) $\chi^2/df < 2$; c) GFI > 0.95 and CFI > 0.95; d) RMSEA < 0.05, bounds of confidence interval for RMSEA are closed to its value, and the lower bound is as close to zero as possible. Based on statistical simulations, it has been suggested that a value of RMSEA as high as 0.08 indicates an acceptable fit (Byrne, 2010). Also, values for GFI and CFI ranging between 0.90 and 0.95 are acceptable.

The fidelity of the Romanian version for the MAQ instrument was estimated by calculating the internal consistency. The well-known α coefficient proposed by J. L. Cronbach is suitable for multiple choice items. The value of α can range between 0 and 1. To conclude that a one-dimensional instrument has internal consistency and is useful for research purposes, $\alpha \geq 0.70$ (Nunnally, 1978). For scales that contain a small number of items (for example, 3-5), values of α between 0.60 and 0.70 are acceptable.

The comparison of math anxiety levels according to the gender of pupils who participated in the study was performed using the *t*-Student test for two independent samples. The critical threshold for determining statistical significance was fixed at $p = 0.05$ (two-tailed).

To test the second of the working hypotheses, the results that the students obtained in mathematics were associated with the scores for the two dimensions of math anxiety, respectively with the distribution of the overall score at the MAQ. The scores at MAQ were quantitative variables, and the semester final grade in mathematics a nominal (categorical) variable. For this reason, it was necessary to recode scores for anxiety towards mathematics, in order to transform them into qualitative variables and to use the non-parametric test $\chi 2$. The procedure we followed required the calculation of means and standard deviations for the distribution of scores at the MAQ. Depending on the values of the descriptive indicators of the distributions, three intervals of variation of the scores were set, corresponding to the low, moderate, and high levels for negative emotions, worry, and overall score at MAQ. The limits of the intervals were set using the criterion M ± *SD*. For example, for negative emotions, M = 1.92 and *SD* = 0.61. The M ± *SD* limits were equal to 1.31, respectively 2.53. Therefore, scores between 1 and 1.31 were considered as indicating a low level of negative emotions, scores between 1.32 and 2.53 a moderate level, and those between 2.54 and 4 a high level. The associations between the distribution of the grades that the students obtained in mathematics in the first semester of the 2018-2019 school year and the distribution of the scores at the MAQ were statistically significant, which is why the effect size was estimated. For this purpose, the values of the coefficient Cramér '*V* were computed. J Cohen (1992) proposed the following benchmarks in order to qualitatively interpret the effect size for the non-parametric test $\chi 2$ used to investigate the association between two nominal variables: 0.10 - low effect, 0.30 - effect moderate, 0.50 - high effect.

5. Results

5.1. Confirmatory factor analysis of the MAQ

The models with one-factor (χ^2 = 83.43; *df* = 44; p < 0.001; χ^2/df = 1.89; GFI = 0.903; CFI = 0.885; RMSEA = 0.081; 90% CI for RMSEA = 0.054-0.108) and two correlated latent factors (χ^2 = 83.21; *df* = 43; p < 0.001; χ^2/df = 1.93; GFI = 0.903; CFI = 0.883; RMSEA = 0.083; 90% CI for RMSEA = 0.056-0.109) provided modest statistical fit. One way to improve the fit of the two-factor model was to relax the constraint of no correlated error of measurement – in particular, to relax the constraint with respect to items 1 and 4, respectively items 1 and 6 (see Table 1). All these items concerned the emotional dimension of math anxiety. This change produced a better model fit: χ^2 = 72.62; *df* = 41; p < 0.01; χ^2/df = 1.77; GFI = 0.918; CFI = 0.908; RMSEA = 0.075; 90% CI for RMSEA = 0.046-0.103. Factor loadings for this model are presented in Figure 1. The factor concerning negative emotions accounted for 15.1-48.6% of the variance in the items 1, 2, 4-6, 9, and 11. The factor concerning worry accounted for 11.8-38.2% of the variance in the items 3, 7, 8, and 10.

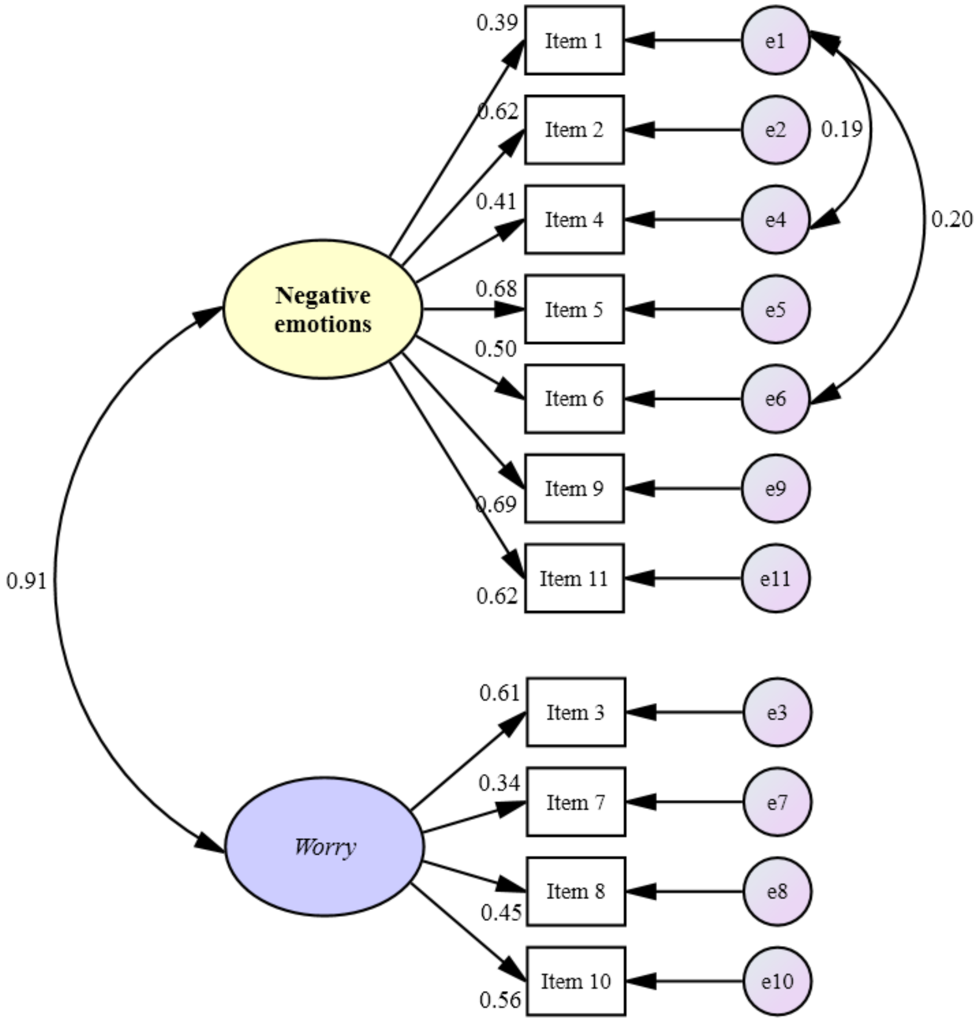

Figure 1. Estimated parameters for the MAQ factor model

Because the number of items assigned to each of the two factors was uneven (seven items for *negative emotions* and four items for *worry*), the score for each dimension was obtained by calculating the average scores for the corresponding items (possible range: 1-4). The correlation between the scores for the two dimensions was equal to 0.60 ($p < 0.001$). Also, for each student, an overall score was calculated at MAQ (possible range: 1-4). High or very high scores (≥ 3) indicated high levels of cognitive preoccupations, respectively negative emotional reactions to the study of mathematics.

For the fourth-grade students who participated in the present study, the values of the coefficient α were: 0.81 - all items of the MAQ instrument, 0.77 - scale corresponding to the dimension of *Negative emotions*, 0.67 - scale corresponding to the dimension of *Worry*.

5.2. Descriptive analyses

Table 2 presents the descriptive values for the distributions of the main variables of interest.

Table 2: Descriptive statistics for MAQ scores

MAQ scales	Minim	Maxim	*M*	*SD*	*Skewness*	*Kurtosis*
Negative emotions	1	3.71	1.92	0.61	0.58	- 0.28
Worry	1	3.75	1.96	0.61	0.69	0.21
MAQ global	1	3.73	1.94	0.55	0.61	0.21

The distributions of the scores that the fourth-grade students obtained for the two dimensions of math anxiety, respectively the distribution of the total score for the MAQ did not show significant deviations from the condition of normality (Sava, 2011). However, in relation to the possible range of variation in scores for the MAQ, students showed a tendency to report moderate to low levels for both dimensions of math anxiety as well as for the global level. It is noteworthy that 20.4% of the students surveyed obtained a moderate to high, high or very high score (located above a standard deviation from the distribution mean) for the dimension of *negative emotions*. Also, 15.3% of the students obtained a moderate to high, high or very high score for the *worry* dimension. Whereas 16.05% obtained a moderate to high, high or very high overall score. Eight (5.8%) of the students who participated in the study obtained an overall score ≥ 3.04, i.e. a score with at least two standard deviations above the distribution mean. This result can be considered an indicator of the prevalence that math anxiety presented for the sample of fourth-grade students.

The analysis of the answers that the fourth-grade students gave to each of the items in the MAQ provided us with an overview on the aspects regarding the study of mathematics that were sources of anxiety. Thus, 18.2% of the students reported that they were worrying about how well they were doing in math. The percentage of students who reported worrying that they would fall behind their peers when they were absent from school and missed a new math lesson was equal to 37.2%. This result has a double significance: a) on the one hand, it can highlight the category of students who have an above average interest in the study of mathematics or are passionate about this field; such students can place more emphasis on the importance of constant attendance at math classes and of increasing the effort for learning (both in the context of the instructional-educational activities carried out in the classroom and of the homework); these two factors contribute to reducing the likelihood of difficulties occurring and of decreasing performance in acquisition evaluation tasks; b) on the other hand, the result may include the category of students who are motivated to study mathematics only in order to achieve the goals they propose in their own educational path; such students are aware that certain goals in their knowledge may prevent them from achieving the performance they are pursuing.

Over 37% of the students surveyed expressed fears about the tests they had to give in mathematics. Furthermore, 27.8% of the students reported feeling scared during their math tests. These results highlight a rather high extent of the emotional discomfort that the assessment of knowledge in mathematics (very common in the school environment), produced. The anticipatory fear of some of the students about the possibility to fail the tests they have to take in mathematics puts into play the assessments that a student can make regarding his own theoretical knowledge and practical skills in the field of mathematics, aspiration level and expectations regarding the performance, the expectations that the parents and the teachers have regarding the achievements in mathematics, the stake that determines the achievement of a good performance, as well as the particular characteristics of the evaluation situations.

5.3. Comparative data

Table 3 summarizes the comparison data by gender of the students who participated in the study.

Table 3: Math anxiety levels by pupils' gender

Dependent variables	**Subsamples**	***M***	***SD***	**t**	**p**
Negative emotions	Girls	2.01	0.66	1.83	0.068
	Boys	1.82	0.53		
Worry	Girls	2.03	0.66	1.42	0.157
	Boys	1.88	0.54		
MAQ global	Girls	2.02	0.60	1.90	0.059
	Boys	1.84	0.47		

Although, compared to boys, girls achieved an average higher by 0.15-0.19 for math anxiety dimensions, the differences were not statistically significant. The score for *negative emotions* revealed a marginal difference in statistical significance. A similar result was obtained for the overall score at the MAQ. In addition, both girls and boys have shown a tendency to report moderate to low levels for math anxiety dimensions. Therefore, the comparative data did not support the working hypothesis H1.

5.4. Correlational analysis

The association between the sex of students who participated in the study and the performances they obtained in mathematics at the end of the first semester of the 2018-2019 school year was not statistically significant ($\chi2 = 0.87$; $p = 0.647$). No significant differences were found between girls and boys for all the levels of performance at semester level in mathematics.

The performance that the students recorded in mathematics at the end of the first semester of the 2018-2019 school year was significantly associated with the level of negative emotions ($\chi2 = 24.47$; $p <0.001$; Cramér '*V* = 0.30), the level of worry ($\chi2 = 18.42$; $p <0.01$; Cramér '*V* = 0.26), as well as the total score on MAQ ($\chi2 = 17.85$; $p <0.01$; Cramér' *V* = 0.25). For all these associations, the size effect was moderate. Over 18% of the students surveyed reported a low level of negative emotions they experienced in relation to the study of mathematics and at the same time obtained at the end of the first semester of the 2018-2019 school year at least the *well* grade. Overall, 68.6% of the students who participated in the study reported at most a moderate level of negative emotions and, at the same time, obtained at least the *well* grade. On the other hand, 72.2% of the students in the fourth grade reported at most a moderate level of cognitive concerns and, at the same time, obtained at least the *well* grade. Also, over 72% of the students reported at most a moderate global level of math anxiety and at the same time they obtained at least the *well* grade. Thus, the correlational data confirmed the working hypothesis H2.

6. Discussions

Math anxiety can emerge as early as primary school (Ashcraft, Krause, & Hopko, 2007; Vukovic et al., 2013) and tends to remain more stable over time among girls (Ma & Xu, 2004). When not properly treated, the level of math anxiety escalates and can significantly impact the performance that students later achieve in this discipline. Thus, high levels of math anxiety have been found to be a negative predictor of the achievement and performance that students of different ages achieve (Ashcraft & Kirk, 2001; Ashcraft, Krause, & Hopko, 2007; Hembree, 1990; Ma, 1999). However, an inverse relationship was also discovered: the low levels of acquisitions and results in math tests lead, in time, to the triggering and/or intensification of the anxiety-specific manifestations towards mathematics (Ma & Xu, 2004; Norwood, 1994; Satake & Amato, 1995), especially for boys (Ma & Xu, 2004).

Despite the interest that researchers show towards math anxiety, studies targeting the young school population are quite rare (Gierl & Bisanz, 1995; Supekar et al., 2015; Vukovic et al., 2013). The investigation that we carried out in a sample of 137 Romanian students of the fourth grade aimed to cover this shortcoming. Descriptive data highlighted the students' concern not to lag behind their peers when they were absent from school and missed a lesson in mathematics. Moreover, among the aspects that predominated in the image of manifestations of math anxiety, the fears related to the tests in mathematics were highlighted. The analysis of the scores that the students obtained at the MAQ showed moderate to low levels for both dimensions of math anxiety. Also, the comparisons according to the gender of the students showed similar results. The girls did not differ significantly from the boys in terms of MAQ scores. In contrast, levels of negative emotions, anxiety, and global math anxiety were significantly associated with the performance that students achieved in mathematics at the end of the first semester of the 2018-2019 school year. The intensity of the association relationship was more consistent for the emotional dimension of math anxiety. This result confirmed the findings of other studies (Wigfield & Meece, 1988).

Certain particularities of individual development, such as the level of skills and abilities for the study of mathematics, working memory capacity, or attitudes toward mathematics (Ashcraft, Krause, & Hopko, 2007) make a significant contribution to the emergence and exacerbation of anxiety in mathematics among students of different ages. To these are added environmental factors, including those related to parents' expectations, school climate, and particularities of classroom instructional activities (Bursal & Paznokas, 2006; Ramirez, Shaw, & Maloney, 2018; Thomas & Furner, 1997; Yüksel- Shah, 2008). The findings of the studies confirm that the teaching and assessment style of the primary-school teacher or teacher of mathematics, respectively the emotional climate during the hours of mathematics play an important role in explaining the attitudes that the students develop towards this discipline of study (Ashcraft & Moore, 2009; Bursal & Paznokas, 2006; Thomas & Furner, 1997).

7. Practical implications

Success in mathematics is closely linked to the attitudes that students develop in relation to this discipline of study. To achieve the expected performance, students should consider mathematics as enjoyable, useful and valuable in relation to achieving the educational path and individual development goals. Unfortunately, quite a few of the students of different ages develop the symptoms specific to math anxiety. For a student facing this debilitating psychological and educational condition, mathematics can create more than a feeling of anxiety or worry. Math anxiety also affects the psychophysiology of the child. Thus, the increase of the heart rate and the electrical conductance appears. Some children report unpleasant somatic conditions (for example, stomachaches or headaches), and cortisol levels, one of the most important stress-signaling hormones, greatly increase and impact the performance that subjects achieve in math-specific or cognitive tasks situations in which their knowledge of mathematics is tested (Suárez-Pellicioni, Núñez-Peña & Colomé, 2016).

Once installed, math anxiety begins to generate negative cognitions and counterproductive ruminations. Often, these cognitive products refer to the possible consequences of failure in the tasks that the student has to solve in mathematics or to the tests/exams they have to take in this discipline of study (Ashcraft & Kirk, 2001). When an anxious student engages in specific work tasks, two things happen simultaneously in his mind. First, the brain deals with keeping negative thoughts about failure under control. Secondly, the student tries to focus on solving tasks. Cognitive resources (i.e., working memory and executive functions) should be optimally directed towards solving work tasks. However, in the case of students who are anxious about mathematics, they are consumed by ruminations about inability to solve tasks or failure.

The Program of International Student Achievement (PISA) developed by the Organization for Economic Cooperation and Development includes the standardized assessment of the acquisitions that students in grades I-VIII have in mathematics, exact sciences and reading, as well as attitudes towards these disciplines and towards school in general. In 2012, the PISA program was conducted in 65 countries, including Romania. It was found that 33% of students up to 15 years of age reported feelings of helplessness when solving math exercises and problems (as cited in Ramirez, Shaw, & Maloney, 2018). According to a study conducted in the school population in Romania by A. Clinciu and collaborators (as cited in Mihailescu, 2017), students who participate in national examinations of Capacity and Baccalaureate tend to feel a higher level of stress in relation to mathematics testing, compared to the tests for Romanian. Therefore, math anxiety is a problem that needs attention both from primary-school teachers and teachers who teach mathematics, as well as from researchers and specialists in the field of psycho-pedagogical counseling.

Through the characteristic manifestations, as well as by the impact that they can have on the performances that the students obtain during the educational route, math anxiety has multiple psycho-pedagogical meanings. One of the directions that these meanings can be analyzed concerns the optimization of the activity of teaching mathematics in the primary cycle and of the approach of evaluating the acquisitions that the students of grades I-IV make in this discipline of study important for the school route. Students need to be helped to understand that math only looks like a tough subject, especially for the uninitiated. But once you have a good understanding of the concepts, all math problems and exercises become “beautiful applications”. The effects of this attitude on the part of the teacher are expressed as: a) stimulating the motivation of the students to discover mathematics; b) permanent training of the cognitive-intellectual skills that they have (through constant involvement in solving the tasks they receive in class and homework, as well as participating in school competitions); c) developing the capacities necessary for mastering mathematical logic; d) development of a positive attitude towards performance in mathematics.

8. Conclusions

Math anxiety refers to states of fear, nervous tension and worry, which some students experience when they carry out activities that involve notions and practical skills in the field of mathematics. This phenomenon, which can occur from early childhood, has a complex etiology and multiple negative consequences with psycho-pedagogical implications. The high level of math anxiety is associated with lower levels of performance in specific tasks and results of tests and examinations in mathematics, as well as with a variety of negative attitudes towards this theoretical and practical field.

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