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Research Article

Math Anxiety and Math Competence: The Different Components of Math Anxiety May Produce Different Effects on Math Performance

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Abstract

Introduction: Given the critical importance of math proficiency, considerable research has focused on identifying the factors that contribute to math achievement. Extensive research has demonstrated a negative correlation between math performance and mathematics anxiety, that is the anxiety that appears specifically when the subject has to deal with numbers. However, it is known that there are students who, despite having a high level of mathematics anxiety, manage to achieve adequate math performance. The present report focused specifically on the competence acquired by students characterized by a high level of mathematics anxiety. Materials and Method: The study involved students who were followed in their first year of secondary school. Students were assessed on two separate occasions: first at the end of the first term, and then again at the end of the second term. Based on the scores obtained in the anxiety questionnaire, students scoring above the mean by one standard deviation were categorized as having high levels of anxiety. Furthermore, based on the results obtained in the math test conducted at the end of the year, these high mathematics anxiety students were divided into two subgroups in relation to whether they had acquired the minimum levels of competence required by the school curriculum. Results: Pearson's correlation coefficient shows an inverse relationship between the level of mathematics anxiety and the score obtained in the math test. However, the subgroup analysis shows that, compared to their peers who had not acquired the expected skills, students who are both highly math anxious and good math achievers present an equivalent high fear of judgement but a significantly higher interest in studying mathematics. Mathematics anxiety, even when high, does not necessarily prevent the acquisition of math skills. Discussion: The data are discussed in light of the different interpretations that students can provide of their state of anxiety when faced with the difficulty of the task to be solved: it is likely that interest in studying mathematics can counterbalance the fear of an unwanted judgment. Conclusions: Ultimately, results suggest taking proper account of individual heterogeneity of math anxious students and highlight the need to adopt a teaching approach that considers individual differences in the management of emotions.

Keywords

Mathematics Anxiety, AMAS, Math Achievement, Adolescence, Educational Psychology, Mathematics Performance, Secondary School Students

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1. Introduction

Learning mathematics is often considered very challenging and sometimes a source of great discomfort [1, 2]. In this regard, in recent years, the "mathematics anxiety" (MA) has received increasing attention [3-6]. This specific anxiety emerges exclusively when dealing with numbers, does not manifest during tasks related to other subjects and differs from other forms such as trait anxiety (which refers primarily to personality characteristics), state anxiety (which manifests itself when one finds oneself facing some difficulty) or social anxiety (which appears in particular situations, such as when one has to speak in public). Already in 1972, Richardson and Suinn [7] defined MA as "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations". This type of adverse reaction to mathematics presents itself with not only emotional but also neurovegetative and behavioral manifestations [8-10] and its theoretical structure as an autonomous entity has now been corroborated by the identification of its neurophysiological and neurobiological basis [11-15]. Furthermore, extensive research has demonstrated a negative correlation between MA and math test performance [16-21]. This correlation not only affects academic outcomes but also extends to influencing future educational and career decisions [22-24].

Numerous evaluation scales have been developed for detection of MA in clinical and educational settings [25]. A questionnaire that has proven to be very valid is the Abbreviated Math Anxiety Scale (AMAS) [26]. AMAS has been translated into several languages, showing its transcultural validity [27-29]. In Italian, three versions are available for primary, lower secondary and upper secondary schools [30-32]. The questionnaire consists of 9 items to which the student must respond according to a scale from 0 to 5, where the highest score corresponds to the highest level of anxiety. The AMAS questionnaire is composed of two subscales, one focused on anxiety related to learning mathematics (five items) and the other on anxiety related to assessment situations in mathematics (four items). These two subscales are believed to measure the two main constitutive dimensions of MA [26, 30-33].

In our previous investigations [34, 35], we found that math performance is inversely related to MA, regardless of state and trait anxiety levels: students with higher MA levels tended to achieve lower math scores; this trend was observed in the math performance administered at both the beginning and the end of the school year. Moreover, anxiety levels were inversely related to the students' ability to acquire new mathematical skills: in the comparison of scores between the initial and final math tests, students who did not show an improvement in the second test were found to have significantly higher levels of MA than those who exhibited an improvement. Our survey involved students from the first year of secondary school. The students performed a standardized test to evaluate the skills achieved in mathematics and answered the standardized AMAS questionnaire for the evaluation of MA. To verify the evolution of learning in relation to the presence and intensity of anxiety, the survey was conducted on two occasions, at the beginning and at the end of the school year. The presence of anxiety at the beginning of the school year seems to be an indicator of the risk of encountering difficulties in learning mathematics and in achieving the minimum skills required by the study curriculum. The use of the AMAS questionnaire was therefore proposed as a useful tool to identify at the beginning of the school year which and how many students might need specific educational support.

An aspect of the problem that has not yet been sufficiently explored concerns the presence of students who, despite having a high level of MA, manage to achieve adequate mathematical performance [36]. High levels of anxiety are found not only in students who do badly in mathematics, but also in some students who show adequate mathematical performance [37]. This data appears to contradict the general rule of a negative influence of MA on learning and therefore raises some doubts about the correct interpretation of this phenomenon. This further analysis of the data collected from our survey refers to students who at the beginning of the school year showed a very high level of anxiety. Based on previous reports in the literature [38] and our personal observations [39, 40], we wanted to verify the presence of differences in the characteristics of the high MA between students who, at the end of the year, showed or did not show that they had achieved the math skills required by the school program.

2. Materials and Methods

2.1. Subjects

The study participants were 73 Italian-speaking students (59 male and 14 female) attending the first grade of a technical vocational secondary school (corresponding to grade nine of English-speaking schools and of the Italian INVALSI evaluation system [41]), who were enrolled through convenience sampling. The mean age at the time of the beginning of the school year, when students first participated in our study, was 14 years and 7 months (SD=4 months, range=14–15.1 years). Diagnosis of dyscalculia or a specific learning disorder (as documented by the certification issued by the health authority to the educational institution to organize a personalized treatment in accordance with the Italian guidelines on specific learning disabilities) was an exclusion criterion. The participants and their parents were informed about the purposes of the research and provided written informed consent. Participation in the study did not include any type of reward. The study received approval from CEAS, the Ethics Committee of the Health Authorities of the Umbria Region (Italy).

2.2. Procedure

Students were assessed on two separate occasions: first in January, at the end of the first term (T0), and then again in June, at the end of the second term (T1). In Italian schools, this period corresponds to formal testing periods of the level of learning achieved by the students. All participants completed the questionnaire designed to assess MA, as well as another questionnaire evaluating both state and trait anxiety; then, they undertook a standardized math test. To isolate the impact of anxiety from potential variations in task difficulty, the same mathematics test was administered at T0 (at the beginning of the school year) and T1 (at the end of the school year). All assessments were conducted individually in the classroom during regular school hours, and students were informed that their data would not be shared with their teachers.

2.3. Measures

2.3.1. Abbreviated Math Anxiety Scale

The "Abbreviated Math Anxiety Scale" (AMAS), one of the most widely employed scales to measure MA, is a questionnaire comprising nine items, each rated on a 5-point Likert scale, resulting in a total score ranging from a minimum value of 9 to a maximum value of 45 [26]. The questionnaire consists of two distinct subscales: "Learning Math Anxiety" and "Math Evaluation Anxiety". More precisely, five items explore anxiety related to math study (for example, "Carefully listening to the math lesson" or "Starting a new topic in mathematics"), while the other four explore anxiety related to assessment situations (for example, "Doing a written math examination/test" or "Having an oral test on math without knowing in advance"). In this study, we used the Italian version validated by Primi et al. [31]. The Italian adaptation of AMAS exhibits psychometric properties similar to those of the original test with respect to internal consistency (Cronbach's alpha ≥0.80) and test–retest reliability (Cronbach's alpha ≥0.81); furthermore, the two dimensions established in the original AMAS (Learning Math Anxiety and Math Evaluation Anxiety) were evident also in the Italian version as well as the invariance across genders; in addition, transcultural validity of MA assessment with the AMAS has been documented in numerous studies [27-29] and the Italian version has allowed collaborative studies between researchers of different languages, for example, Italian and English [19, 42].

2.3.2. Battery for the Assessment of Calculation

The "Battery for the Assessment of Calculation Ability" (ABCA 14-16) is a battery of paper-pencil tests for the assessment of math skills in individuals aged 14- to 16-year-old [43]. This battery of tests has been constructed with reference to the modular model of McCloskey et al. [44] which hypothesizes that the mental representation of numerical knowledge is independent of other cognitive systems and is structured in three modules which are in turn functionally distinct. The items assess different levels of mathematical proficiency by requiring the solution of tasks of different complexity (for example, "145.28–23.39 =" or "57.8 × 2.94 ="). To identify which components of mathematical processing are deficient and provide a specific profile of the student examined, the score obtained is compared to the criteria of the normative sample. In this way, each student can be classified into one of four possible performance bands: optimal performance (scores ≥ 70th percentile), sufficient performance (scores between the 40th and 69th percentile), slight difficulties that need to be supported (scores between the 11th and 39th percentile), severe difficulties that require specific teaching attention (scores ≤ 10th percentile). In other words, the math test score indicates whether the performance corresponds to the expected one in terms of age and education and makes it possible to identify students who, showing underperformances, require educational support. This assessment tool is widely used in Italy to establish whether students have successfully acquired the math skills outlined for their current academic year, that is the educational objectives set by the school curriculum.

In the present study, we considered subtests that in the first phase of our investigation were found to be affected only by the level of MA and not by state or trait anxiety. These subtests specifically consist of advanced math skills that investigate how students have stored combinations of numbers within the calculation system and whether they are able to access them automatically (for example, "2+3 × 4 =" or "$100/10^2$ ="). Scoring is based on the number of correct answers and ranges from zero, denoting the lowest level of performance, to a maximum of 28.

2.4. Statistical Analysis

For data analysis, we utilized the Jamovi program [45]. Descriptive statistics, including mean and SD, were applied to describe the scores obtained from the AMAS questionnaire and ABCA 14-16 test. The relationship between MA levels at T0 and math performance at T1 was examined using the Pearson correlation coefficient. To further investigate this relationship, students were divided into more homogeneous subgroups. Based on the AMAS scores, students scoring above the mean by one SD were categorized as having high levels of anxiety (High-MA, High Math Anxiety), and those scoring below the mean by one SD were identified as having low levels of anxiety (Low-MA, Low Math Anxiety). Furthermore, based on the results obtained in the math test conducted at the end of the year, students who met or surpassed the required competencies, as demonstrated by scoring above the cut-off of the normative sample, were categorized into those who showed a successful acquisition of the required competencies (A-MC, Achieved Math Competence). Conversely, those who did not meet the minimum required competencies, as demonstrated by scoring below the cut-off, were included in the failure of acquisition of math competence subgroup (F-MC, Failed Math Competence).

To compare the scores obtained by the subgroups in both the math test and the anxiety questionnaire, a Levene test was performed to assess the equality of variances. Student's t-test for unpaired samples was used for homogeneous variances, otherwise Welch's t-test was employed. Additionally, a Fisher exact test was employed to examine the distribution patterns of students with high and low MA within the subgroups characterized by sufficient (A-MC) and insufficient (F-MC) math performance.

3. Results

The AMAS questionnaire performed at T0 yielded an average anxiety level of 21.79±6.12. Subscale "Learning Math Anxiety" showed an average score of 8.45±2.77, and subscale "Math Evaluation Anxiety" an average score of 13.42±4.15. As regards the mathematical test performed at T1, the average score obtained was 16.37±6.3. The correlation coefficient showed an inverse relationship between the score obtained on the AMAS questionnaire and on the math test ($r=-0.386$, $p=0.002$). This relationship persisted even considering separately the two "Learning Math Anxiety" ($r=-0.388$, $p=0.002$) and "Math Evaluation Anxiety" ($r=-0.306$, $p=0.02$) components of the AMAS questionnaire. In summary, higher levels of MA at the beginning of the school year were associated with lower scores on the math test at the end of the year (Figure 1).

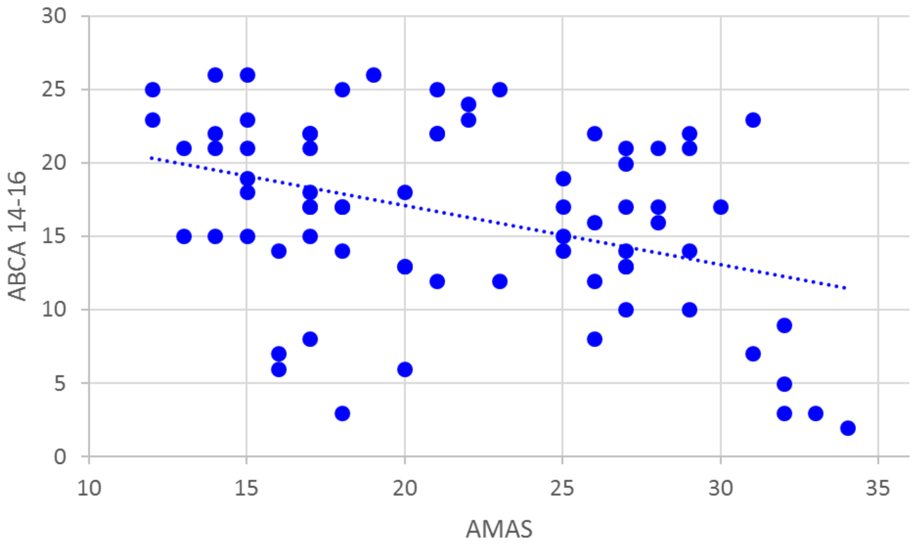

Figure 1. *The relationship between perceived anxiety about mathematics and performance on the mathematics test: higher levels of MA at the beginning of the school year were associated with lower scores on the math test at the end of the year. AMAS, score obtained at the beginning of the school year on the on the Math Anxiety Assessment Questionnaire; ABCA 14-16, score obtained at the end of the school year on the Italian battery for the assessment of calculation ability.*

Within this framework, students who have or have not acquired the expected math skills and those with high and low MA were identified. There were 52 (71.23%) students belonging to the A-MC subgroup, characterized by a successful acquisition of mathematics competence (M=19.62±3.73), while 21 (28.77%) belong to the F-MC subgroup, showing a failure of acquisition of mathematics competence (M=8.33±3.77). The disparity in math scores between these two subgroups was statistically significant ($p<0.001$). Furthermore, students in the F-MC subgroup showed significantly ($p<0.001$) higher AMAS scores (M=25.1±6.03) than those in the A-MC subgroup (M=20.46±5.69). In summary, students who fail to achieve the required mathematical skills show, already at the beginning of the school year, a significantly higher level of MA than their peers who do (Figure 2).

Regarding the AMAS questionnaire, there were 15 (20.55%) students belonging to the High-MA subgroup (M=30.33±1.95), while 14 (19,18%) belonged to the Low-MA subgroup (M=14±1.11). The disparity in AMAS scores between these two subgroups was statistically significant ($p<0.001$). None of the Low-MA students were present in the F-MC subgroup. Conversely, High-MA students are present in both the A-MC and F-MC subgroups. A Fisher exact test indicated a significant difference in the distribution of High-MA and Low-MA students across the A-MC and F-MC subgroups ($p<0.01$). Furthermore, students in the Low-MA subgroup showed significantly ($p<0.001$) better math performance (M=20.71±3.87) than those in the High-MA subgroup (M=12.67±7.54). In summary, the students who report high levels of MA at the beginning of the school year perform significantly worse in math tasks at the end of the year than their Low-MA peers.

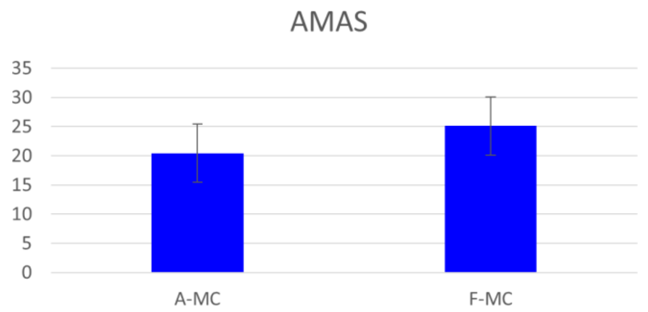

Figure 2. *Scores obtained at the beginning of the school year on the Math Anxiety Assessment Questionnaire (AMAS) by students who, at the end of the year, have acquired (A-MC) or not acquired (F-MC) the minimum mathematics competence required by the school curriculum: students who fail to achieve the required math skills show a significantly higher level of MA.*

Subgroup analysis of High-MA students revealed that 7 of them (i.e. 33,33% of 21) belonged to the F-MC subgroup with a mean math score of 5.57 ±2.92. Conversely, 8 students (i.e. 15.38% of 52) were found to belong to the A-MC subgroup, having achieved the minimum competences required by the school curriculum (M=18.87±3.06). The difference in math scores between these two subgroups was statistically significant ($p<0.001$). In other words, some students, despite a high level of anxiety, still showed adequate mathematical performance.

The AMAS score of the High-MA students belonging to the A-MC subgroup was 29±1, while the students belonging to the F-MC subgroup obtained an average score of 31.85±1.45. The comparison shows a significant difference ($p<0.001$). The analysis of the AMAS subscales shows a difference between these two subgroups (Table 1). Indeed, for the subscale "Math Evaluation Anxiety", the mean score was 18±1.22 for the A-MC students and 18.57±1.99 for the F-MC students. The difference was not statistically significant ($p=0.54$). In contrast, for the subscale "Learning Math Anxiety", the average score was 11±1.11 for the A-MC students and 13.28±1.98 for the F-MC students. This difference was statistically significant ($p<0.02$).

Table 1. *Abbreviated Math Anxiety Scale (AMAS) scores (mean ± SD) obtained by students with high levels of Math Anxiety on "Learning Math Anxiety" subscale and "Math Evaluation Anxiety" subscale: comparison between students with sufficient (A-MC) or insufficient (F-MC) acquisition of expected math skills.*

AMAS	Learning Math Anxiety*	Math Evaluation Anxiety
A-MC	11 (± 1.11)	18 (± 1.22)
F-MC	13.28 (± 1,98)	18.57 (± 1.99)

* $p < 0.02$

It is also interesting to underline that the score obtained by the A-MC students in the "Learning Math Anxiety" subscale is within the average, that is, it is lower than the values (Mean ± SD = 12) that identify the presence of a high level of anxiety.

These findings suggest the opportunity to examine the two constituent components of MA separately: a high total score can in fact be determined by a high score in only one of the two components.

4. Discussion

The present study is part of a longitudinal investigation aimed at exploring the potential relationship between MA and learning mathematics. The evaluation involved students who were followed in their first year of secondary school. We consider this stage critical for identifying the risk of mathematical difficulties, as it represents a transitional phase in the mathematics curriculum, serving as a bridge between students' past experiences with math and the development of future learning strategies [46]. Furthermore, this period coincides with adolescence, a pivotal time in students' lives characterized by notable emotional and behavioral changes [47].

Our data agree with the shared notion that high levels of MA are associated with significantly lower math performance; however, our attention was paid to the performance of students who at the beginning of the year showed a high level of anxiety. Our findings suggest that some students are both highly math anxious in math and good achievers. Notably, high MA does not invariably impair performance, and its presence does not necessarily prevent the acquisition of the math skills required by the educational curriculum.

In our opinion, to interpret these conflicting data, we should keep in mind the multidimensionality of MA [48]. There is no consensus on the number and type of MA dimensions [49], but at least two components have been unanimously identified in international studies: math learning and math testing anxiety [19, 26, 27, 30, 50]. Based on the data derived from the sample we examined, it is possible to hypothesize a different effect on the math performance of the two MA components examined by the AMAS questionnaire: students who, despite high MA, manage to achieve the skills required by the school program, compared to their colleagues who do not succeed, show the same level of evaluation anxiety but a significantly lower level of learning anxiety. These High-MA students seem to be particularly sensitive to the fear of judgment but show average scores regarding interest in studying mathematics. It can be hypothesized that interest in learning mathematics can counterbalance the fear of an unwanted judgment.

In the literature, other data seems to suggest similar conclusions [38]. For example, it has been reported that women, despite showing a higher level of anxiety than men, then obtain equivalent performance [51]. In other words, MA in women seems not to have repercussions on performance [52]. Furthermore, interest in mathematics has been found to be more important to students' career decisions than their knowledge of mathematics, as measured by SAT (Scholastic Assessment Test) scores [53].

Lyons and Beilock [54] hypothesized that college students with high anxiety, but good performance, might reinterpret their state of arousal during testing situations. In one of their neuroimaging studies, they asked students to complete math and verbal tasks of similar difficulty. The type of task was indicated in advance. In this way, the researchers were able to separate brain activation associated with anticipation from that associated with the actual execution of mathematical calculations. It was observed that in the period between the warning of the upcoming math test and the actual completion of the problems, students who, despite being anxious, performed the task correctly activated a fronto-parietal network known to be involved in the control of negative emotions [55]. Furthermore, the greater the activation of this network, the better the performance. The other students, however, did not show this activation. The Authors suggested that the activation of this brain network corresponds to the effort to positively reevaluate one's physiological arousal before starting the math task. Students with little interest in math would not be able to use these processes of positive reevaluation of the contextual situation to regulate their emotional experience [56, 57]. As a result, negative worries may hinder working memory, which is known to be essential for solving math tasks [58-60].

Precisely the type of interpretation of one's current and past experiences with mathematics may be the key factor in determining the debilitative or facilitative effects of MA on math performance. In support of this hypothesis, neuroimaging studies have also documented that MA activates two neural networks: the pain network involving the insula [12] and the fear network centered on the amygdala [11, 15]. Interestingly, activation of the pain network does not correlate with task performance per se, but rather with its anticipation [61]. Ultimately, MA, if it led to interpreting the task as threatening, would determine an attitude of renunciation and avoidance in the face of difficulties and therefore cause increasingly poor performance [12, 62].

On the contrary, a certain degree of MA could have beneficial effects whether individuals interpret math situations as positive and challenging. Students who believe that mistakes are part of the learning process and that good results can be achieved through commitment to study may consider anxiety as an inevitable phenomenon when facing difficulties and consider it positively as a challenge to test and improve their competence [63]. In other words, it is possible that for some students it may be better to maintain moderate levels of anxiety [38]. On the other hand, according to the well-known inverted U law of Yerkes & Dodson [64], optimal learning occurs thanks to an intermediate level of anxiety, while both too low and too high levels are associated with reduced learning efficiency. In this regard, Pletzer et al. [65] found the involvement of basic attentional processes: comparing participants with high and with low MA matched for their mathematical performance, they found stronger deactivation within the default mode network in Low-MA than in High-MA, suggesting that a high level of MA reduce the ability to appropriately activate one's cognitive resources.

The findings from our study indicate that students with high MA and good proficiency exhibit significantly lower levels of anxiety in the “Learning Math Anxiety” subscale but not in the “Math Evaluation Anxiety” subscale. This suggests that MA manifests itself in all students as apprehension toward the task at hand and the associated judgment. Conversely, students differ in terms of their interest in the study of mathematics, and this difference appears to be reflected in their ability to acquire new learning.

An important limitation to the results of our analysis comes from the small sample used. Therefore, our results cannot be generalized. On the other hand, it must be kept in mind that our analysis was addressed to individuals who belong to one extreme of the population distribution, that with a very high level of MA (i.e. 20.55 % of the sample examined). A second possible limitation concerns the different types of educational institutions. In fact, mathematics teaching can vary quantitatively and qualitatively depending on the type of school; for example, Italian students who chose science and technology courses seem to show significantly lower MA than students who chose humanities and social sciences courses (31). Further studies are therefore needed to evaluate the possible different effects of mathematics teaching on the math performance of students who follow different types of study programs (17). More generally, it should be kept in mind that MA represents only one of the many factors that can justify poor performance; for example, the school and family contexts certainly appear to be very important; these factors, moreover, interact with each other in complex ways. It therefore appears difficult to consider MA in isolation and further studies appear necessary to establish how generalizable our data are.

However, differentiating the anxiety of a bad grade and the consequences of a failure from the anxiety due to the difficulty of the task to be faced could have a practical impact on the development of more targeted remediation approach for alleviating the discomfort felt towards mathematics.

5. Conclusions

Mathematical skills are considered one of the key competencies necessary for coping with our daily life activities and their importance has increased with the development of current technology [66]. Furthermore, math achievement strongly predicts whether students are likely to select – and succeed in – science, technology, engineering, and mathematical (STEM) fields and this academic choice in turn influences future career decisions [3, 67, 68]. It is therefore somewhat surprising to observe a progressive decline in math skills in both the school and adult populations, as shown by surveys by international educational institutions [41, 69].

Certainly, numerous mechanisms, which can largely be categorized into individual, interpersonal, and environmental factors, have been identified that can reduce math learning. However, MA proves to be a widespread problem, impacting children, adolescents and adults worldwide and its negative influence on math performance has been widely investigated and acknowledged [70, 71].

The findings of our investigation support the notion that the presence of MA can significantly contribute to hindering the acquisition of educational outcomes. However, a high level of MA does not always lead to the onset of difficulties in learning mathematics. Specifically, our High-MA students who achieve the expected math skills at the end of the school year show a dissociation between the two AMAS subscales, with a high level on the evaluation anxiety but an average level on the learning anxiety. This dissociation could suggest the existence of different subtypes of MA and, consequently, the need for different approaches to educational intervention [72]. In conclusion, our results suggest that different anxious components may differently influence the ability to acquire new competencies: interest in studying mathematics seems to be a sign of the ability to face and overcome difficulties related to the fear of the consequences of failure.

This interpretation obviously needs further research to be confirmed, but we thought it would be interesting to propose it to stimulate a line of research that has been poorly investigated so far but which seems to have relevant consequences from a practical point of view, especially with regards to teaching [73].

Doubtless, many different reasons can generate MA among the school students, but the role of teachers seems to be vital: teachers (as well as parents) serve as role models and can significantly influence how a student approaches the study of mathematics [74-76]. For example, it has been suggested that MA does not stem directly from the study of mathematics but occurs mainly due to the way mathematics is taught and presented [77-79].

Teachers should therefore consider the importance of their attitudes and expectations and, in school settings, should follow both general rules and strategies aimed at the specific characteristics of individual students.

On the basis of our findings, an additional possibility available to identify the presence and type of emotional difficulties associated with the study of mathematics could be represented by the separate evaluation of the two components of the MA: indeed, a high total score can in fact be determined by a high score in only one of the two components and noting the prevalence of the anxious component towards learning or towards evaluation should suggest different teaching approaches. For example, in High-MA students whit low scores on learning anxiety, reducing evaluation anxiety could lead to a marked increase in performance.

Therefore, every teacher should first ascertain the presence and intensity of anxiety; then define the profile of its two components, evaluate the concomitance of trait and state anxiety, identify any other interfering factors and design educational interventions aimed at individual characteristics.

As for learning anxiety, teachers should demonstrate, for example, that mathematics is essential everywhere in our daily life activities and is a valuable tool in real life situations, such as counting change or shopping. Furthermore, they should dispel stereotypes and misconceptions such as the myth that mathematical ability is innate and that success depends on talent, regardless of effort [80, 81].

As for evaluation anxiety, instructional approaches should be designed to address not only the cognitive but also the emotional challenges associated with studying mathematics [56, 63, 82, 83]; negative experiences in the classroom should always be avoided, placing less emphasis on the accuracy of the answer and on the speed of execution and giving more importance to suggesting a useful way to obtain the desired result.

Furthermore, firstly, teachers should be aware that a large piece of literature suggests that anxiety can be mitigated, resulting in significant performance improvements: in this sense, for example, various relaxation, reappraisal and cognitive-behavioral techniques have been successfully used [14, 84-87].

Research of this kind underscores the need for interventions to address and manage MA in educational contexts. In any case, measuring and trying to eliminate MA from the school context should be a primary goal of good educational practice [88]. In our opinion, our data may contribute to the existing knowledge about MA and stimulate much more research on this issue.

Abbreviations

ABCA	Battery for the Assessment of Calculation Ability
AMAS	Abbreviated Math Anxiety Scale
A-MC	Achieved Math Competence
F-MC	Failed Math Competence

High-MA	High Math Anxiety
INVALSI	Istituto Nazionale per la Valutazione del Sistema Educativo di Istruzione e di Formazione
Low-MA	Low Math Anxiety
MA	Mathematics Anxiety
OECD	Organization for Economic Cooperation and Development
SAT	Scholastic Assessment Test
STEM	Science, Technology, Engineering, and Mathematics

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Author Contributions

Massimo Piccirilli: Conceptualization, Methodology, Supervision, Writing – original draft, Writing – review & editing

Gianni Alberto Lanfaloni: Conceptualization, Data curation, Investigation, Writing – review & editing

The authors contributed equally to writing the article.

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Data Availability Statement

The data is available from the corresponding author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] Attard, C. (2013). “If I had to pick any subject, it wouldn’t be maths”: foundations for engagement with mathematics during the middle years. Mathematics Education Research Journal, 25: 569–587. https://doi.org/10.1007/s13394-013-0081-8

[2] Brown, M., Brown, P., & Bibby, T. (2008). “I would rather die”: reasons given by 16-year-olds for not continuing their study of mathematics. Research in Mathematics Education, 10: 3–18. https://doi.org/10.1080/14794800801915814

[3] Carey, E., Devine, A., Hill, F., Dowker, A., McLellan, R., & Szucs, D. (2019). Understanding Mathematics Anxiety: Investigating the experiences of UK primary and secondary school students. Cambridge, UK: Centre for Neuroscience in Education. https://doi.org/10.17863/CAM.37744

[4] Caviola, S., Toffalini, E., Giofrè, D., Ruiz, J. M., Szűcs, D., & Mammarella, I. C. (2021). Math performance and academic anxiety forms, from sociodemographic to cognitive aspects: A meta-analysis on 906,311 Participants. Educational Psychology Review, 34: 363–399. https://doi.org/10.1007/s10648-021-09618-5

[5] Radević, L., & Milovanović, I. (2024). Current Trends in Math Anxiety Research: a Bibliometric Approach. International Journal of Science and Mathematics Education, 22: 1345–1362. https://doi.org/10.1007/s10763-023-10424-4

[6] Zhang, J., Zhao, N., & Kong, Q. P. (2019). The Relationship Between Math Anxiety and Math Performance: A Meta-Analytic Investigation. Frontiers in Psychology, 10: 1613. https://doi.org/10.3389/fpsyg.2019.01613

[7] Richardson, F. C., & Suinn, R. M. (1972). The mathematics anxiety rating scale: Psychometric data. Journal of Counceling Psychology 19: 551–4. https://doi.org/10.1037/h0033456

[8] Gough, M. F. (1954). Why failures in mathematics? Mathemaphobia: Causes and treatments. The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 28: 290–294. https://doi.org/10.1080/00098655.1954.11476830

[9] Hembree, R. (1990). The nature, effects, and relief of mathematics anxiety. Journal for Research in Mathematics Education, 21: 33–46. https://www.jstor.org/stable/749455

[10] Szczygieł, M., & Pieronkiewicz, B. (2021). Exploring the nature of math anxiety in young children: Intensity, prevalence, reasons. Mathematical Thinking and Learning, 1-19. https://doi.org/10.1080/10986065.2021.1882363

[11] Artemenko, C., Daroczy, G., & Nuerk, H-C. (2015). Neural correlates of math anxiety – an overview and implications. Frontiers in Psychology, 6: 1333. https://doi.org/10.3389/fpsyg.2015.01333

[12] Lyons, I. M., & Beilock, S. L. (2012a). When math hurts: math anxiety predicts pain network activation in anticipation of doing math. PloS One, 7(10): e48076. https://doi.org/10.1371/journal.pone.0048076

[13] Suárez-Pellicioni, M., Núñez-Peña, M. I., & Colomé, À. (2016). Math anxiety: a review of its cognitive consequences, psychophysiological correlates, and brain bases. Cognitive, Affective and Behavioral Neuroscience, 16: 3–22. https://doi.org/10.3758/s13415-015-0370-7

[14] Supekar, K., Iuculano, T., Chen, L., & Menon, V. (2015). Remediation of childhood math anxiety and associated neural circuits through cognitive tutoring. The Journal of Neuroscience, 35: 12574–83. https://doi.org/10.1523/JNEUROSCI.0786-15.2015

[15] Young, C. B., Wu, S. S., & Menon, V. (2012). The neurodevelopmental basis of math anxiety. Psychological Science, 23: 492–501. https://doi.org/10.1177/0956797611429134

[16] Ashcraft, M. H. (2002). Math anxiety: personal, educational, and cognitive consequences. Current Direction in Psychological Science, 11: 181–185. https://doi.org/10.1111/1467-8721.00196

[17] Barroso, C., Ganley, C. M., McGraw, A. L., Geer, E. A., Hart, S. A., & Daucourt, M. C. (2021). A meta-analysis of the relation between math anxiety and math achievement. Psychological Bulletin, 147: 134-168. https://doi.org/10.1037/bul0000307

[18] Demedts, F., Reynvoet, B., Sasanguie, D., & Depaepe, F. (2022). Unraveling the role of math anxiety in students' math performance. Frontiers in Psychology, 13: 979113. https://doi.org/10.3389/fpsyg.2022.979113

[19] Hill, F., Mammarella, I. C., Devine, A., Caviola, S., Passolunghi, M. C., & Szűcs, D. (2016). Maths anxiety in primary and secondary school students: Gender differences, developmental changes and anxiety specificity. Learning and Individual Differences 48: 45-53. https://doi.org/10.1016/j.lindif.2016.02.006

[20] Ma, X. (1999). A meta-analysis of the relationship between anxiety toward mathematics and achievement in mathematics. Journal for Research in Mathematics Education, 30: 520-540. https://doi.org/10.2307/749772

[21] Sokolowski, H. M., & Ansari, D. (2017). Who is afraid of math? What is math anxiety? And what can you do about it. Frontiers. Young Minds, 5: 57. https://doi.org/10.3389/frym.2017.00057

[22] Cipora, K., Santos, F. H., Kucian, K., & Dowker, A. (2021). Mathematics anxiety – where are we and where shall we go? Annals of the New York Academy of Sciences, 1513: 10–20. https://doi.org/10.31234/osf.io/2xpcg

[23] Dowker, A., Sarkar, A., & Looi, C. Y. (2016). Mathematics anxiety: What have we learned in 60 years? Frontiers in Psychology, 7: 508. https://doi.org/10.3389/fpsyg.2016.00508

[24] Maloney, E. A., & Beilock, S. (2012). Math anxiety: who has it, why it develops, and how to guard against it. Trends in Cognitive Sciences, 16: 404–6. https://doi.org/10.1016/j.tics.2012.06.008

[25] Eden, C., Heine, A., & Jacobs, A. M. (2013). Mathematics anxiety and its development in the course of formal schooling—a review. Psychology, 4: 27-35. https://doi.org/10.4236/psych.2013.46A2005

[26] Hopko, D. R., Mahadevan, R., Bare, R. L., & Hunt, M. A. (2003). The Abbreviated Math Anxiety Scale (AMAS): Construction, validity, and reliability. Assessment 10: 178–82. https://doi.org/10.1177/1073191103010002008

[27] Cipora, K., Szczygieł, M., Willmes, K., & Nuerk, H. C. (2015). Math anxiety assessment with the abbreviated math anxiety scale: Applicability and usefulness. Insights from the Polish Adaptation. Frontiers in Psychology 6: 1833. https://doi.org/10.3389/fpsyg.2015.01833

[28] Martín-Puga, M. E., Justicia-Galiano, M. J., Gómez-Pérez, M. M., & Pelegrina S. (2022). Psychometric Properties, Factor Structure, and Gender and Educational Level Invariance of the Abbreviated Math Anxiety Scale (AMAS) in Spanish Children and Adolescents. Assessment, 29: 425-440. https://doi.org/10.1177/1073191120980064

[29] Vahedi, S., & Farrokhi, F. (2011). A confirmatory factor analysis of the structure of abbreviated math anxiety scale. Iranian Journal of Psychiatry, 6: 47-53.

[30] Caviola, S., Primi, C., Chiesi, F., & Mammarella, I. C. (2017). Psychometric properties of the Abbreviated Math Anxiety Scale (AMAS) in Italian primary school children. Learning and Individual Differences 55: 174-182. https://doi.org/10.1016/j.lindif.2017.03.006

[31] Primi, C., Busdraghi, C., Tommasetto, C., Morsanyi, K., & Chiesi, F. (2014). Measuring math anxiety in Italian college and high school students: Validity, reliability and gender invariance of the Abbreviated Math Anxiety Scale (AMAS). Learning and Individual Differences 34: 51–6. https://doi.org/10.1016/j.lindif.2014.05.012

[32] Primi, C., Donati, M. A., Izzo, V. A., Guardabassi, V., O'Connor, P. A., Tomasetto, C., & Morsanyi, K. (2020). The Early Elementary School Abbreviated Math Anxiety Scale (the EES-AMAS): A New Adapted Version of the AMAS to Measure Math Anxiety in Young Children. Frontiers in Psychology, 11: 1014. https://doi.org/10.3389/fpsyg.2020.01014

[33] Carey, E., Devine, A., Hill, F., & Szűcs, D. (2017). Differentiating anxiety forms and their role in academic performance from primary to secondary school. PLoS One 12: e0174418. https://doi.org/10.1371/journal.pone.0174418

[34] Buratta, L., Piccirilli, M., Lanfaloni, G. A., Ilicini, S., Bedetti, C., & Elisei, S. (2019). Mathematics anxiety and cognitive performance in adolescent students. Psychiatria Danubina 31: 479-485.

[35] Piccirilli, M., Lanfaloni, G. A., Buratta, L., Ciotti, B., Lepri, A., Azzarelli, C., Ilicini, S., D'Alessandro, P., & Elisei, S. (2023). Assessment of math anxiety as a potential tool to identify students at risk of poor acquisition of new math skills: longitudinal study of grade 9 Italian students. Frontiers in Psychology, 14: 1185677. https://doi.org/10.3389/fpsyg.2023.1185677

[36] Lee, J. (2009). Universals and specifics of math self-concept, math self-efficacy, and math anxiety across 41 PISA 2003 participating countries. Learning and Individual Differences, 19: 355–365. https://doi.org/10.1016/j. lindif.2008.10.009

[37] Devine, A., Hill, F., Carey, E., & Szűcs, D. (2018). Cognitive and Emotional Math Problems Largely Dissociate: Prevalence of Developmental Dyscalculia and Mathematics Anxiety. Journal of Educational Psychology, 110: 431-444. https://doi.org/10.1037/edu0000222

[38] Wang, Z., Lukowski, S. L., Hart, S. A., Lyons, I. M., Thompson, L. A., Kovas, Y., Mazzocco, M. M., Plomin, R., & Petrill, S. A. (2015). Is Math Anxiety Always Bad for Math Learning? The Role of Math Motivation. Psychological Science, 26: 1863-1876. https://doi.org/10.1177/0956797615602471

[39] Lanfaloni, G. A., Piccirilli, M., D'Alessandro, P., Ilicini, S., Baccarelli, P., & Elisei, S. (2023). The Relationship Between Math Anxiety and Math Achievement: Differentiating the Role of Learning Math Anxiety and Math Evaluation Anxiety. Psychiatria Danubina, 35: 53-56.

[40] Piccirilli, M. (2024). Math Anxiety and Poor Math Competence: A Longitudinal Investigation of Students Failing to Achieve the Math Skills Required by School Curricula. Journal of Clinical Psychology and Neurology, 2: 1-5. https://doi.org/10.61440/JCPN.2024.v2.23

[41] Invalsi open. (2022). Rapporto nazionale 2022. https://www.invalsiopen.it/risultati/risultati-prove-invalsi-2022/

[42] Wang, Z., Rimfeld, K., Shakeshaft, N., Schofield, K., & Malanchini, M. (2020). The longitudinal role of mathematics anxiety in mathematics development: Issues of gender differences and domain-specificity. Journal of Adolescence, 80: 220-232. https://doi.org/10.1016/j.adolescence.2020.03.003.

[43] Baccaglini-Frank, A., Perona, M., Bettini, P., Caviola, S., & Lucangeli, D. (2013). Test ABCA 14–16. Prove di abilità di calcolo avanzato per la scuola secondaria di secondo grado. Trento (Italy): Erickson Ed.

[44] McCloskey, M., Caramazza, A., & Basili, A. (1985). Cognitive mechanisms in number processing and calculation: evidence from dyscalculia. Brain Cognition, 4: 171–196. https://doi.org/10.1016/0278-2626(85)90069-7

[45] Jamovi. (Version 2.3) [Computer Software] 2022. https://www.jamovi.org/download.html

[46] Field, A, P., Evans, D., Bloniewski, T., & Kovas, Y. (2019). Predicting maths anxiety from mathematical achievement across the transition from primary to secondary education. Royal Society Open Science, 6: 191459. https://doi.org/10.1098/rsos.191459

[47] Järvelä, S. (2011). Social and Emotional Aspects of Learning. Amsterdam: Elsevier Academic. Press.

[48] Namkung, J. M., Peng, P., & Lin, X. (2019). The relation between mathematics anxiety and mathematics performance among school-aged students: A meta-analysis. Review of Educational Research, 89: 459-496. https://doi.org/10.3102/0034654319843494

[49] Henschel, S., & Roick, T. (2020). The Multidimensional Structure of Math Anxiety Revisited. European Journal of Psychological Assessment, 36: 123–135. https://doi.org/10.1027/1015-5759/a000477

[50] Lindberg, S. M., Hyde, J. S., Petersen, J. L., & Linn, M. C. (2010). New trends in gender and mathematics performance: a meta-analysis. Psychological Bulletin, 136: 1123–1135. https://doi.org/10.1037/a0021276

[51] Devine, A., Fawcett, K., Szűcs, D., & Dowker, A. (2012). Gender differences in mathematics anxiety and the relation to mathematics performance while controlling for test anxiety. Behavioral and Brain Functions 8: 33. https://doi.org/10.1186/1744-9081-8-33

[52] Goetz, T., Bieg, M., Lüdtke, O., Pekrun, R., & Hall, N. C. (2013). Do Girls Really Experience More Anxiety in Mathematics? Psychological Science 24: 2079–87. https://doi.org/10.1177/0956797613486989

[53] Chipman, S. F., Krantz, D. H., & Silver, R. (1992). Mathematics anxiety and science careers among able college women. Psychological Science, 3: 292–296. https://doi.org/10.1111/j.1467-9280.1992.tb00675.x

[54] Lyons, I. M., & Beilock, S. L. (2012b) Mathematics anxiety: Separating the math from the anxiety. Cerebral Cortex, 22: 2102–2110. https://doi.org/10.1093/cercor/bhr289

[55] Pizzie, R. G., & Kraemer, D. J. (2021). The association between emotion regulation, physiological arousal, and performance in math anxiety. Frontiers in Psychology, 12: 639448. https://doi.org/10.3389/fpsyg.2021.639448

[56] Brunyé, T. T., Mahoney, C. R., Giles, G. E., Rapp, D. N., Taylor, H. A., & Kanarek, R. B. (2013). Learning to relax: Evaluating four brief interventions for overcoming the negative emotions accompanying math anxiety. Learning and Individual Differences 27: 1–7. https://doi.org/10.1016/j.lindif.2013.06.008

[57] García-Suárez, P. C., Ramos-Álvarez, M. M., & Fernández-Martín, P. (2021). Emotional self-regulation and academic performance in university students with mathematics anxiety. Journal of Numerical Cognition, 7(1), 53-72. https://doi.org/10.5964/jnc.v7i1.395

[58] Mammarella, I. C., Caviola, S., Giofrè, D., & Borella, E. (2018). Separating math from anxiety: The role of inhibitory mechanisms. Applied Neuropsychology, Child. 7: 342-353. https://doi.org/10.1080/21622965.2017.1341836.

[59] Pelegrina, S., Justicia-Galiano, M. J, Martín-Puga, M. E., & Linares, R. (2020). Math Anxiety and Working Memory Updating: Difficulties in Retrieving Numerical Information from Working Memory. Frontiers in Psychology, 11: 669. https://doi.org/10.3389/fpsyg.2020.00669.

[60] Van den Bussche, E., Vanmeert, K., Aben, B., & Sasanguie, D. (2020). Too anxious to control: the relation between math anxiety and inhibitory control processes. Sci Rep. 10: 19922. https://doi.org/10.1038/s41598-020-76920-7.

[61] Aupperle, R. L., Melrose, A. J., Francisco, A., Paulus, M. P., & Stein, M. B. (2015). Neural substrates of approach-avoidance conflict decision-making. Human Brain Mapping, 36: 449-462. https://doi.org/10.1002/hbm.22639

[62] Mattarella-Micke, A., Mateo, J., Kozak, M. N., Foster, K., & Beilock, S. L. (2011). Choke or thrive? The relation between salivary cortisol and math performance depends on individual differences in working memory and math-anxiety. Emotion. 11: 1000-1005. https://doi.org/10.1037/a0023224

[63] Jamieson, J. P., Mendes, W. B., Blackstock, E., & Schmader, T. (2010). Turning the knots in your stomach into bows: reappraising arousal improves performance on the GRE. Journal of Experimental Social Psychology 46: 208–212. https://doi.org/10.1016/j.jesp.2009.08.015

[64] Yerkes, R. M., & Dodson, J. D. (1908). The relation of strength of stimulus to rapidity of habit-formation. Journal of Comparative Neurology and Psychology, 18: 459-482.

[65] Pletzer, B., Kronbichler, M., Nuerk, H.-C., & Kerschbaum, H. H. (2015). Mathematics anxiety reduces default mode network deactivation in response to numerical tasks. Frontiers in Human Neuroscience, 9: 202. https://doi.org/10.3389/fnhum.2015.00202

[66] Parsons, S., & Bynner, J. (2005). Does numeracy matter more? London, NRDC Research Report.

[67] Daker, R. J., Gattas, S. U., Sokolowski, H. M., Green, A. E., & Lyons, I. M. (2021). First-year students' math anxiety predicts STEM avoidance and underperformance throughout university, independently of math ability. Science of Learning, 6: 17. https://doi.org/10.1038/s41539-021-00095-7

[68] Holmes, K., Gore, J., Smith, M., & Lloyd, A. (2018). An integrated analysis of school students' aspirations for STEM careers: Which student and school factors are most predictive? International Journal of Science and Mathematics Education, 16: 655–675.

[69] OECD (2024). An Evolution of Mathematics Curriculum: Where It Was, Where It Stands and Where It Is Going. OECD Publishing, Paris. https://doi.org/10.1787/0ffd89d0-en.

[70] Foley, A. E., Herts, J. B., Borgonovi, F., Guerriero, S., Levine, S. C., & Beilock, S. L. (2017). The math anxiety-performance link: a global phenomenon. Current Direction in Psychological Science, 26: 52–58. https://doi.org/10.1177/0963721416672463

[71] Lau, N. T. T., Hawes, Z., Tremblay, P., & Ansari D. Disentangling the individual and contextual effects of math anxiety: A global perspective. Proceedings of the National Academy of Sciences of the USA. 119: e2115855119, 2022. https://doi.org/10.1073/pnas.2115855119

[72] Daker, R. J., Gattas, S. U., Necka, E. A, Green, A. E., & Lyons, I. M. (2023). Does anxiety explain why math-anxious people underperform in math? NPJ Science of Learning, 8: 6. https://doi.org/10.1038/s41539-023-00156-z

[73] Saglam, M. H., & Goktenturk, T. (2024). Mathematically high and low performances tell us different stories: Uncovering motivation-related factors via the ecological model. Learning and Individual Differences 114: 102513. https://doi.org/10.1016/j.lindif.2024.102513

[74] Cao, Y., Lavicza, Z., An, S., & Dong, L. (2024). Psychological studies in the teaching, learning and assessment of mathematics. Lausanne: Frontiers Media SA. https://doi.org/10.3389/978-2-8325-4690-1

[75] Casad, B.J., Hale, P., & Wachs, F. L. (2015). Parent-child math anxiety and math-gender stereotypes predict adolescents' math education outcomes. Frontiers in Psychology, 6: 1597. https://doi.org/10.3389/fpsyg.2015.01597

[76] Soni, A., & Kumari, S. (2017). The role of parental math anxiety and math attitude in their children's math achievement. International Journal of Science and Mathematics Education, 15: 331–347. https://doi.org/10.1007/s10763-015-9687-5

[77] Geist, E. (2010). The anti-anxiety curriculum: Combating math anxiety in the classroom. Journal of Instructional Psychology, 37: 24–31.

[78] Jackson, C. D., & Leffingwell, R. J. (1999). The role of instructors in creating math anxiety in students from kindergarten through college. Mathematics Teacher, 92: 583–586. https://doi.org/10.5951/MT.92.7.0583

[79] Turner, J. C., Meyer, D. K., Anderman, E. M., Midgley, C., Gheen, M., Kang, Y., & Patrick, H. (2002). The classroom environment and students' reports of avoidance strategies in mathematics: A multimethod study. Journal of Educational Psychology, 94: 88. https://doi.org/10.1037//0022-0663.94.1.88

[80] Luttenberger, S., Wimmer, S., & Paechter, M. (2018). Spotlight on math anxiety. Psychology Research and Behavior Management, 11: 311-322. https://doi.org/10.2147/PRBM.S141421

[81] Rattan, A., Good, C., & Dweck, C. S. (2012). "It's ok — Not everyone can be good at math": Instructors with an entity theory comfort (and demotivate) students. Journal of Experimental Social Psychology, 48: 731–737. https://doi.org/10.1016/j.jesp.2011.12.012

[82] Abín, A., Núñez, J. C., Rodríguez, C., Cueli, M., García, T., & Rosário, P. (2020). Predicting mathematics achievement in secondary education: The role of cognitive, motivational, and emotional variables. Frontiers in Psychology, 11: 876. https://doi.org/10.3389/fpsyg.2020.00876

[83] Passolunghi, M. C., De Vita, C. & Pellizzoni, S. (2020). Math anxiety and math achievement: the effects of emotional and math strategy training. Developmental Science, 23: e12964. https://doi.org/10.1111/desc.12964

[84] Park, D., Ramirez, G., & Beilock, S. L. (2014). The role of expressive writing in math anxiety. Journal of Experimental Psychology: Applied, 20: 103-111. https://doi.org/10.1037/xap0000013

[85] Samuel, T. S., & Warner, J. (2021) "I can math!": reducing math anxiety and increasing math self-efficacy using a mindfulness and growth mindset-based intervention in first-year students. Community College Journal of Research and Practice. 5: 205-222. https://doi.org/10.1080/10668926.2019.1666063

[86] Sokolowski, H. M., & Necka, E. A. (2016). Remediating math anxiety through cognitive training: potential roles for math ability and social context. Journal of Neuroscience, 36: 1439-1441. https://doi.org/10.1523/JNEUROSCI.4039-15.2016

[87] Yeager, D. S., & Dweck, C. S. (2012). Mindsets that promote resilience: when students believe that personal characteristics can be developed. Educational Psychologist, 47: 302–314. https://doi.org/10.1080/00461520.2012.722805

[88] Furner, J. M., & Duffy, M. (2002). Equity for all students in the new millennium: Disabling math anxiety. Intervention in School and Clinic, 38: 67-74. https://doi.org/10.1177/10534512020380020101

Biography

Massimo Piccirilli is a professor at Perugia University, Department of Medicine (Institute of Neurology, Institute of Psychiatry, and School of Speech and Language Therapy). He was founder and director of the Cognitive Rehabilitation Unit (URIC) of the Perugia Hospital. He has written numerous articles on neuropsychology and neuroscience and six books on the mind-brain relationship.

Gianni Alberto Lanfaloni is a Clinical Psychologist at the Serafico Institute of Assisi (Italy) and is the Head of the Clinical Functional Evaluation Unit and the Specific Learning Disorders Unit. He graduated in Psychology with a focus on Applied Psychology in 1984 from the University of Rome and completed his Psychotherapy training in 1993.

Research Field

Massimo Piccirilli: Neurology, psychiatry, neuropsychology and cognitive rehabilitation, aphasia, dementia

Gianni Alberto Lanfaloni: Learning disorders in reading, writing, and arithmetic, Math anxiety in childhood, Application of Cognitive-Behavioral methods in Intellectual Disabilities, Rehabilitative intervention in developmental dyslexia, Neuropsychological evaluation in neurodevelopmental disorders