

MATHS ANXIETY IN THE LAST 10 YEARS: MEASUREMENT SCALES

Laura Barrera-Romero¹, Carlos Fresneda-Portillo², & Salvador Reyes-de-Cózar³

¹Department of Quantitative Methods, Universidad Loyola Andalucía (Spain)

²Department of Mathematics and Computing, Universidad de Burgos (Spain)

³Department of Education, Universidad Loyola Andalucía (Spain)

Abstract

Maths Anxiety is a widespread phenomenon in the educational context that affects learning, academic performance, and the choice of educational paths related to mathematics. In a context marked by digitalization and the growth of STEM sectors, mastery of mathematical and data-processing skills has become a fundamental requirement for accessing an increasing number of emerging jobs, reinforcing the need to address this problem from an educational perspective. This study analyses the scales used between 2015 and 2024 to measure Maths Anxiety in school-aged children and teenagers through a systematic review following the PRISMA methodology. Thirty-three articles published in Scopus and Web of Science were selected. Then, we analysed the scales applied within each article globally and also at an item-level, paying particular attention to the education stage at which the instruments were applied. The results show a high diversity of scales regarding the focus of study, number of items, and age of the selected samples. Greater attention is observed to the factors involved in personal and academic Maths Anxiety, and a lower presence of studies in the early educational stages.

Keywords: *Maths anxiety, school-aged children, scales, educational stages, intervention strategies.*

1. Introduction

Maths Anxiety is a problem that affects a growing number of people. It was first defined in 1972 as the feeling of anxiety, worry, distress, or unease that an individual experiences when faced with mathematical problems, by Richardson and Suinn (Escalona, 2019). Since then, many authors have conducted research on this concept.

In recent years, Maths Anxiety has become a significant problem in classrooms. The increasing use of technology and the demand for jobs related to data management, analysis, and interpretation have driven the need for professionals with STEM skills (Martín Colomo et al., 2024). In this sense, mathematical competence is a key skill for future employability, though it can be limited by anxiety about the subject. Therefore, it is essential to closely monitor Maths Anxiety among students and implement early detection and intervention strategies to prevent it from becoming increasingly serious.

In this study, we will analyze the scales used to measure Maths Anxiety over the last decade, with the aim of identifying the aspects that should be considered in their study and whether there are differences in the aspects addressed by age. Finally, we will determine whether scales exist that measure Maths Anxiety in accordance with the scientific literature, or whether, on the contrary, it would be necessary to design a model of Maths Anxiety that does so.

2. Methodology

A systematic review was conducted using the PRISMA (Preferred Reporting Items Systematic Reviews and Meta-Analyses) methodology (Hutton et al., 2016). For article selection, eligibility criteria were first defined according to the PICO (Participants Intervention Context Outcomes) format, according to Reyes-de-Cózar et al., 2022. At this point, we would like to clarify that, unlike the PICO format designed for the Health Sciences field, the one selected for this study is a modified PICO format, to adapt it to the context of Social Sciences. Based on these criteria, articles (no other types of publications such as book chapters) published between 2015 and 2024 (inclusive) that studied the causes of Maths Anxiety in typically developing, school-aged students (children and adolescents) were selected. Articles written in languages other than English or Spanish, and those that focused their study on the intervention of Maths Anxiety,

were excluded. These articles had to be published in Scopus and Web of Science (WOS), as these are the leading databases in the Social Sciences. A three-stage screening process was carried out: title review, abstract review, and full-text review. Afterwards, a content analysis was conducted with the information obtained. Finally, 33 articles were included in the review according to the established criteria. For data collection, an Excel spreadsheet was designed to record the names of the scales, the elements addressed, and the range of ages of the sample considered. Given the wide variety of elements, a classification was established based on each element's nature (Crespo-Díaz et al., 2023), reducing the amount of information and facilitating its analysis. For example, in the Revised Mathematical Anxiety Rating Scale (RMARS) from Article 16, aspects of *teaching style*, *teaching quality*, and *teaching competence* are measured. These are classified by the authors as a *teacher role* and by our study as an *academic element*. This process was carried out on the 33 articles included in the review.

To understand the target dimensions of the Mathematics Anxiety instruments which emerged from the literature review, we classified the items of the scales into four different categories: elements of a personal nature (P), which include those that collect information useful for the study of Mathematical Anxiety as manifested by the student; elements of an academic nature (A), which encompass those that manifest in the educational institution; contextual elements (C), which manifest themselves through the family and the student's immediate developmental environment; and exogenous elements (E), which include indicators that do not belong to any of the previous groups and over which neither group has any influence, such as each country's education law. The information extracted from the 33 articles is detailed in Table 1.

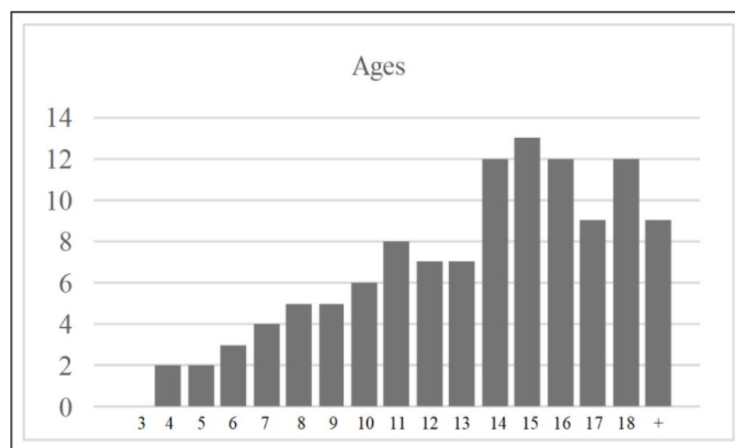
Table 1. Selected information from the articles.

	Y.P.	SCALES	Y.C.	NATURE	AGES
A01	2024	Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ)	2009	P, A	16-17
A02	2021	Semi-structured interview	2021	C, E	9-11
A03	2017	Abbreviated Math Anxiety Scale (AMAS)	2003	P, A	8-11
		Revised Children's Manifest Anxiety Scale: Second Edition (RCMAS-2)	2012		
A04	2022	Mathematics Motivation Questionnaire (MMQ) for Secondary School Students	2021	P	18+
A05	2019	Maths Anxiety Scale (MAS)	2009	A	18+
		Mathematics Anxiety Scale (MAS)	2009		
A06	2017	Mathematics-computing attitudes scale		P	18+
A07	2017	Mathematics and Technology Attitudes Scale (MTAS)			
A08	2018	Revised Mathematics Anxiety Rating Scale (RMARS)	1989	A	18+
A09	2024	Revised Mathematics Anxiety Rating Scale (RMARS)	1989	P, A	14+
A10	2023	PISA 2022	2022	A	15-16
A11	2022	Abbreviated Math Anxiety Scale (AMAS)	2003	P, A	14
		Mathematics Attitudes Scale (MAS)	1961		
A12	2022	Cognitive, Emotions, Physical – Mathematics Anxiety Rating (CEP-MAR)	2022	P, A	15-18
		Trends in International Mathematics and Science Study	2015		
A13	2017	Science Motivation Questionnaire	2011	P, E	12-18
		Career Motivation Subscale of the Science Motivation Questionnaire II			
A14	2024	Differential and General Aptitude Test Battery (BADyG)	2006	P, A	8-12
A15	2017	Math Anxiety Scale (MAS)	2005	P	14
A16	2024	Mathematics Anxiety Scale (MAS)	2009	P, A, C, E	13-17
A17	2022	Mathematics Content Scale	2022	P, A	10-17
		Simplified version of RMARS	2022		
A18	2020	Escala de Ansiedad hacia las Matemáticas (MARS)	2006	P, A	12-16
A19	2024	Mathematics Anxiety Scale-UK (MAS-UK)	2011	A	18+
A20	2018	Arabic version of the Modified-Abbreviated Math Anxiety Scale (m-AMAS)	2020	A	11-17
A21	2023	RMARS Mathematical Anxiety Score Scale (Anxiety toward mathematics)	1989	A	14-18
		Brief Math Anxiety Scale (BMAS)	2020		
		Shortened Math Anxiety Rating Scale (sMARS)		P, A, E	18+

A22	2023	Early Elementary School Abbreviated Math Anxiety Scale (EES-AMAS)	2020	P, C	4-8
		Test of Mathematics Ability (TEMA-3)	2003		
		Curriculum-based Mathematics Assessment for Learning and Teaching (MaLT)	2005		
		Arithmetical Problems from the Calculation Subtests of the Woodcock-Johnson III tests	2001		
		Revised Child Math Anxiety Questionnaire (CMAQ-R)	2016		
A23	2019	Math Anxiety Scale (MANX)	1898	P, A	13-15
A24	2019	Children's Mathematics Anxiety Scale UK (CMAS-UK)	2018	A	4-7
A25	2016	MARS-30 brief (Mathematics Anxiety Rating Scale)	2016	A	18+
A26	2021	Mathematics Anxiety Scale	2018	P, A, C	13-14
		Questionnaire of factors influencing Mathematics Anxiety	2021		
A27	2015	PISA 2003	2003	P, A, C, E	15
A28	2018	Abbreviated Math Anxiety Scale (AMAS)	2003	P, A	15+
		Students Motivation to Learn Mathematics Scale (SMOT)	2003		
		Math Anxiety Questionnaire (MAQ)	2018		
A29	2021	Scale for Early Mathematics Anxiety (SEMA)	2012	P, A	7-12
		Calculation and Math Fluency subtests of the WJ-III Achievement battery	2001		
A30	2024	Revised Child Math Anxiety Questionnaire (CMAQ-R)	2016	A	11
A31	2020	Mathematics Anxiety Rating Scale (MARS)	2006	A	14-16
A32	2020	Mathematic Motivation Scale (MMS)	2013	P, A, E	12
		Mathematics Anxiety Scale for Elementary School Students (MASESS)	2010		
		Modified Abbreviated Math Anxiety Scale (m-AMAS)	2019		
A33	2020	Math Anxiety Questionnaire for Children (MAQC)	2013	P, A	6-11
		Revised Children's Manifest Anxiety Scale (RCMAS)	1978		

Note: the first column corresponds to the nomenclature used to designate each article; the second to the year of publication (Y.P.) of the journal paper reviewed; the third contains the Mathematical Anxiety measurement scales used by the authors; the fourth to the year of creation (Y.C.) of the scale applied in the paper; the fifth specifies the nature to which the elements evaluated by each scale belong (P corresponds to personal, A to academic, C to contextual and E to exogenous); and the sixth specifies the ages of the samples selected for each study included in the review

Figure 1. Ages selected in the study samples.



Note: The values on the X-axis represent the years of the students in the samples selected for the studies included in the review, and the values on the Y-axis represent the number of articles in which each age is considered.

On the one hand, a total of 45 different scales (third column of Table 1) were used during the last decade to assess Maths Anxiety in students, some of which were used more than once among the 33 selected articles. According to the fourth column, some of the scales used between 2015 and 2024 were designed directly to be administered on the study, while others were designed even decades before the development of the study in which they were used.

On the other hand, among established factor classifications, most authors focus on the personal and academic aspects of Maths Anxiety, whereas fewer articles address contextual and exogenous aspects. Finally, according to the data in Figure 1, a preference for studying Mathematical Anxiety is observed as students get older, with 15 years being the age at which they study the most.

3. Discussion and conclusions

The information obtained through content analysis reflects an extensive study of Maths Anxiety during the decade 2015-2024. According to *Table 1*, the authors use a wide variety of scales to measure Maths Anxiety in students, thereby focusing on different causes in each case. Furthermore, it is found that, although the selected studies cover all stages of schooling, not all appear equally compelling for study.

Firstly, considering the scales used in the selected articles, *Table 1* reveals a lack of consensus regarding what should be studied in students to define the presence or absence of Maths Anxiety. Since the focus varies from study to study, the scales vary accordingly, and the scales used by authors with the same focus sometimes differ. In some cases, these differences are due to adaptations of existing scales for use in contexts other than their original ones. That is, modifications or adaptations are made to use a specific scale with a particular sample. In other cases, the differences stem from the wide variety of scales, from which the authors must select for their studies. Nevertheless, some of the scales in the table have been used repeatedly during the decade studied, such as the Abbreviated Maths Anxiety Scale (AMAS), which was used in articles A03, A10, and A28 and modified by the authors of A19 and A33.

For example, some authors focus only on personal aspects (A04, A06, and A14), while others focus only on academic aspects (A05, A18, and A30). Other authors focus their studies on personal and academic aspects (A23) and that, according to Artero et al. (2022) and Sosa (2023), are essential to understand Maths Anxiety; personal and contextual aspects (A22), or all three simultaneously (A26). One of the articles focuses on the least studied aspects: those of a contextual and exogenous nature (A02), and only two addresses at least one aspect of the four established categories (A15 and A27). However, in A15, the Mathematics Anxiety Scale (MAS) is administered to students aged 13-17, whereas in A27, the scale studied is the PISA 2003 for 15-year-old students. Accordingly, A27 stands out compared to A09, since although the PISA 2003 mathematics exams assessed personal, academic, contextual, and exogenous aspects of Maths Anxiety in students, the PISA 2022 version narrowed the study to academic aspects, achieving a more specific content to be evaluated, but losing information that could also be useful for defining Maths Anxiety.

Finally, although the articles included in the review study on Maths Anxiety at all stages of schooling, according to the eligibility criteria defined in previous phases, the focus is primarily on the upper academic stages. Maths Anxiety is less frequently studied among students in the first stage of schooling and is non-existent among 3-year-olds. The age at which the causes of Maths Anxiety are most frequently studied is 15 years old (in 13 of the 33 articles included in the review), although the ages of 14, 16, and 18 vary by one point (in 12 articles included in the review). In contrast, Maths Anxiety in 4- and 5-year-old students is studied in only 2 of the 33 articles included in the review.

The problem observed with the scales used is the wide range of scales available to measure the causes of Maths Anxiety in students. According to the results, the scales differ even when the nature of the causes of Maths Anxiety, i.e. the focus of the study, remains the same. Therefore, it is clear that the aspects we must consider when assessing Maths Anxiety (P, A, C, E). However, even scales that consider the four categories of causes of Maths Anxiety, these scales do not cover comprehensively the nature of each of the four categories. For example: while A15 addresses aspects of the classroom such as *noise level* or *setting* (classified as elements of academic nature), in A27 other aspects are addressed, such as the *mathematics teacher using traditional approach to classess*, related to the teacher but corresponding to the same classification.

Regarding the scales of the reviewed articles, two addressed aspects of the four categories defined by the nature of the factors evaluated. One of these is the 2003 PISA (Programme for International Student Assessment) test, which, in addition to assessing mathematical skills (and levels of Maths Anxiety), also collects information on science and reading skills. Therefore, it is not a scale specifically designed for assessing Maths Anxiety in students. The other scale is the Mathematics Anxiety Scale (MAS), which was specifically designed for measuring Mathematics Anxiety. Therefore, it is the scale we would select if we wanted to measure Maths Anxiety in students aged 13 to 17 (as the authors of the A15 do). However, the scale's reliability could vary when administered to younger students.

For future research, there is an opportunity to design a generic model of Maths Anxiety that considers all the aspects studied in the scientific literature of the four categories, and that takes into account different ages (with the optimal developmental levels specific to each) so that each group its design can be tailored to each study.

In conclusion, for progressing in the study of Maths Anxiety, research horizons must be broadened by designing intervention strategies for different educational stages (Khoo et al., 2024), while respecting developmental stages and the levels of distress students may experience at each stage. Authors such as Palma et al. have already endorsed this proposal (2024), with a proposal for intervention in Mathematical Anxiety, or Colomer et al. (n.d.), who are currently in the process of developing MAGIC, a proposal focused on the development and evaluation of an educational program for primary school students, with the aim of reducing levels of Mathematical Anxiety, as well as increasing student motivation towards the area.

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