



Development of a Mathematics Anxiety Scale

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Abstract

This study aimed to develop and construct a Mathematics Anxiety Scale with strong validity evidence, suitable for use in the Arab context. The standardization sample consisted of 238 students, selected non-randomly from various levels of middle school education. The study followed a systematic scientific methodology, beginning with the preparation of the initial version of the scale, which included 38 items formulated after reviewing theoretical frameworks and previous studies related to mathematics anxiety. These items underwent a series of methodological procedures to verify validity conditions, starting with content validity assessment through a panel of experts in psychology and education.

Cognitive interviews were also conducted with a sample of students to ensure the clarity and comprehensibility of the items for the target group. To verify the internal consistency of the scale, correlation coefficients between each item and the total score were calculated, leading to the elimination of items with weak correlations.

Results of the exploratory factor analysis using the principal components method with Varimax rotation revealed a single dominant factor that explained a large proportion of the total variance. After applying the item retention criterion (loading ≥ 0.30), the final version of the scale was reduced to 32 items representing a unidimensional structure.

Findings indicated that the scale possessed acceptable psychometric properties, with a Cronbach's alpha reliability coefficient of 0.92 for the entire scale.

The study concludes that the final version of the scale is a reliable tool for assessing mathematics anxiety among students and can be used for research, diagnostic, and counseling purposes, thereby contributing to the development of appropriate intervention programs to reduce mathematics anxiety.

Keywords: Mathematics Anxiety, Scale Development, Validity Conditions, Exploratory Factor Analysis.

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Introduction

Mathematics anxiety is the feeling of worry or fear when dealing with mathematical problems. It is not an independent psychological disorder, but rather a specific form of anxiety that arises in situations requiring the use of mathematical skills. A person experiencing math anxiety may feel tense in any context that involves mathematics, whether in school lessons or while calculating a restaurant bill. For some individuals, this anxiety emerges only when they are not allowed to use tools such as calculators or notes, while for others, the anxiety persists even when such tools are available.

Math anxiety is a very common phenomenon. According to a research review published in 2018, approximately 93% of adults in the United States reported experiencing some degree of mathematics anxiety, and it is estimated that about 17% of the population suffers from a severe form of this condition (**Oslyn, 2022**). Similarly, the results of the 2019 Programme for International Student Assessment (PISA) revealed that a large proportion of high school students reported feeling anxious and stressed when completing their mathematics homework (**Elena & Valentina, 2021**).

This highlights mathematics anxiety as a serious academic issue, one that may directly or indirectly affect students due to feelings of stress and fear, particularly impacting their academic achievement. As a result, students may begin to avoid studying mathematics—a subject that is fundamental in school curricula worldwide. This situation underscores the necessity for valid assessment tools that measure this emotional trait.

Our study aims to help bridge certain scientific gaps, the most important of which is the lack of such measurement instruments, especially in the local context. There is a clear need for tools that connect cognitive aspects with emotional traits. Therefore, we are developing a Mathematics Anxiety Scale based on the modern measurement theory, following the steps outlined by **Sebbagh (2025)**, structured into three main phases comprising nine stages.

The importance of this study—developing a mathematics anxiety scale—lies in its contribution to enriching theoretical knowledge in the local environment by providing a valid tool. Moreover, it can enhance the teaching-learning process by offering educators, teachers, and relevant institutions a means to identify and diagnose students suffering from this issue, enabling them to provide timely support and intervention.

Thus, our current study, which aims to develop a valid Mathematics Anxiety Scale, goes beyond the creation of a diagnostic tool. It serves as a proactive step toward improving the quality of education in Algerian schools and contributing to the formation of generations capable of engaging in scientific fields without psychological barriers.

Method Research Design:

The present study employed a non-experimental quantitative research methodology, using the descriptive approach, as it best aligns with the objective of this study—

developing a Mathematics Anxiety Scale for middle school students. The scale was constructed following the steps outlined below.

Participants:

The scale was administered to a standardization sample consisting of 238 participants, with the aim of validating the instrument. Participants were selected through non-random purposive sampling. Access to the sample was facilitated by sharing the survey link or a QR code with students, in coordination with school principals and academic guidance counselors at the selected schools.

Temporal and Geographical Boundaries:

The scale was applied to the pilot sample during the period from November 5, 2024, to November 19, 2024, in the following middle schools:

- *Abdallah Barbar Middle School, Bouderbala, Bouira*
- *Amache Achour Middle School, Zbarbar, Bouira*
- *Kaâoul Hammoud Middle School, Bouira*
- *Bouchentouf Rabah Middle School, Guerrouma, Bouira*

Statistical Methods:

Statistical methods appropriate for each stage of scale development were used, employing the SPSS and JASP software packages. These methods included:

- **Pearson correlation coefficient** for assessing linear relationships.
- **McDonald's Omega** for internal consistency reliability.
- **Cronbach's Alpha** for reliability estimation.
- **Exploratory Factor Analysis (EFA)** to examine the underlying factor structure.

Results

Phase	1:	Item	Formulation
Step 1: Defining the Domain (Trait) and Drafting Items			

A. Defining the Domain

After reviewing various instruments used to measure mathematics anxiety and examining a range of related research studies, the researchers concluded that it is essential to develop a mathematics anxiety scale that meets validity standards. The goal is to provide accurate quantitative and qualitative diagnosis of mathematics anxiety among students, as well as to potentially distinguish students with dyscalculia.

This study is based on an operational definition of mathematics anxiety as a reaction—whether emotional, physical, or cognitive—that may be temporary or chronic, typically occurring in situations where the individual is required to engage in mathematical tasks, whether in the classroom or in everyday life.

B. Item Formulation

Items were developed using the **deductive method**, also known as **logical partitioning** or **top-down classification**, which involves describing the relevant domain (trait) and identifying its components (items). This approach is supported by a thorough review of the literature and evaluation of existing scales and indicators in the field. The item construction was guided by the following studies:

(Živković M, Pellizzoni S, Mammarella IC, & Passolunghi MC, 2022)

(Dubinkina N, Sella F, Vanbecelaere S, & Vanbecelaere S, 2023)

(Li D, Liew J, Raymond D, & Hammond T, 2023)

(Li T, Chen C, & Zhou X, 2023) (Zhang J, Zhao N, & Zhao N, 2019)

(Westfall RS, McAuley AJ, & Millar M)

(Levy HE, Fares L, & Rubinsten O, 2021)

(Finell J, Sammallahiti E, Korhonen J, Eklöf H, & Eklöf H, 2022)

(Artemenko C, Daroczy G, & Nuerk HC, 2015)

(Hart SA & Ganley CM, 2019)

(González-Gómez B, Núñez-Peña MI, & Colomé À, 2023)

Primary items of the scale.

I feel tense as soon as I see a mathematics book.

I feel afraid of the mathematics teacher.

I feel confused when the mathematics teacher asks me a question.

I become nervous when solving a problem on the blackboard.

I think mathematics is mentally exhausting and that I do not need it.

I enjoy solving puzzles or problems related to mathematics.

I feel extreme fear of mathematics exams.

I feel my heart beating rapidly while solving mathematics problems.

I find it difficult to do my mathematics homework.

I am confident that I will obtain a good grade in a mathematics exam.

I feel that mathematics lessons are very long.

I feel annoyed when asked to review mathematics.

I feel enjoyment when learning mathematics.

I feel happy when the mathematics teacher is absent.

I believe I do not have sufficient abilities to make progress in mathematics achievement.

Mathematics makes me feel nervous.

I feel anxious because mathematics is present in all fields of life.

I believe that learning mathematics requires extraordinary intelligence.

I hate mathematics and cannot justify it.

I wish mathematics could be removed from my curriculum.

I feel upset when I see my classmates discussing a mathematics problem or lesson.

I feel tightness in my chest during mathematics class.

I believe that I will not use mathematics in the future, so why should I study it?

I feel helpless in front of mathematics problems.

I believe that I am not good at mathematics, no matter how hard I try.

I feel tense when confronted with a mathematics lesson that I do not understand.

I feel an overwhelming thrill when I succeed in solving a difficult problem.

I feel annoyed when asked to solve a mathematics problem on the board in front of my classmates.

I feel afraid when asked to explain mathematical formulas.

I fear unexpected quizzes in mathematics.

I worry that my family/society will think less of me if I struggle with mathematics.

I feel nervous when thinking about mathematics outside the classroom.

I cannot follow the mathematics teacher when he explains a problem on the board.

I feel disturbed when preparing for a mathematics exam.

I feel embarrassed to raise my hand to ask a question in mathematics class.

Stereotypes about mathematical ability make me doubt myself.

I feel anxious when I hear a classmate explaining a mathematics problem.

I feel anxious when I encounter a mathematical formula in another subject.

I feel judged when my answers in mathematics are incorrect.

I feel embarrassed to raise my hand to ask a question in mathematics class

Step	2:	Content	Validity	Verification
Content validity was assessed through expert judgment. The scale was reviewed by six experts—professors and researchers in the fields of psychology and educational sciences from various Algerian universities—with the aim of evaluating the items in terms of:				

- **Validity** (Measures / Does not measure)
- **Ethical considerations** (Compliant / Non-compliant)
- **Measurability** (Yes / No)
- **Objectivity** (Objective / Biased)

Based on the experts' evaluations, the following items were eliminated:

- *I worry that my family or society will think less of me if I struggle with math.*
- *Stereotypes about math ability make me doubt myself.*
- *I feel judged when my answers in math are incorrect.*

Phase Two: Scale Development

Step 3: Pre-testing Questions

To assess whether the items reflect the construct under study and meet the required standards, cognitive interviews were conducted by presenting the scale to focus groups composed of middle school students. The scale was presented to:

- Three groups of 1st-year students (15 students per group)
- Three groups of 2nd-year students
- Four groups of 3rd-year students
- Five groups of 4th-year students

Based on the feedback obtained, the following item was removed:
"I believe I'm not good at math, no matter how hard I try."

Step 4: Administration and Sample Size

The scale was administered to a standardization sample consisting of **238 students**, using either printed copies or Google

Table No.01: Correlation of the item score with the total item score

Item s	The total score	Item s	The total score	Item s	The total score	Item s	The total score	Item s	The total score
1	** 0.482	8	** 0.529	15	** 0.611	22	** 0.642	29	** 0.494
2	** 0.322	9	** 0.529	16	** 0.660	23	** 0.595	30	** 0.664
3	** 0.507	10	** 0.305	17	** 0.649	24	** 0.706	31	** 0.437
4	** 0.435	11	** 0.692	18	** 0.525	25	** 0.537	32	** 0.442
5	** 0.571	12	** 0.601	19	** 0.744	26	0.041	33	** 0.528
6	** 0.415	13	** 0.324	20	** 0.661	27	** 0.553	34	** 0.588
7	** 0.531	14	** 0.430	21	** 0.571	28	** 0.614	35	** 0.657
** Statistically significant at the significance level of 0.01									

* Statistically significant at the significance level of 0.05

Based on the data presented in the table above, it is observed that most of the item-total correlations were statistically significant at the 0.01 significance level, totaling 34 items. However, it is necessary to remove one item, number (26), due to its lack of internal consistency.

b- Reliability Estimation Technique through Data Analysis Using the Reliability Coefficient:

Table (number) shows the value of the reliability coefficient.

Table No.02: Scale Reliability Coefficient

Reliability coefficient	The value of the reliability coefficient	Number of items	N
Ω	0.93	34	238
A	0.92		

Based on the values presented in the table above, we observe that the reliability coefficient, calculated by relying on individuals' scores across all items, was estimated at **0.92**, which indicates a high level of reliability. Accordingly, and based on this step, **item number 26 was removed from the scale.**

Step 6: Factor Extraction

The factors were then extracted using **exploratory factor analysis (EFA)**, following these steps: EFA was conducted on a sample consisting of **201 participants**, using the **principal components method**, and the results revealed the emergence of [000000 – placeholder for factor names or number of factors].

We then examined the assumptions for using factor analysis as indicated by **Tighza (2012)**. Most of the correlation coefficients exceeded **0.30**, which is the minimum acceptable value in the correlation matrix. Additionally, the **Kaiser-Meyer-Olkin (KMO)** measure of sampling adequacy was **0.893**, which is higher than the threshold of 0.70, and the value of **Bartlett's test of sphericity (Chi-square)** was **3603.890**, which is statistically significant at the **0.01 level**.

These values indicate that the quality of the measurement and the model fit is **good**.

Table No.03: Degree of Saturation of Items

N	Indicator	Saturation
1	I feel tense as soon as I see a mathematics book.	0.544
2	I feel afraid of the mathematics teacher	0.643
3	I feel confused when the mathematics teacher asks me a question	0.712
4	I become nervous when solving a problem on the blackboard	0.660
5	I think mathematics is mentally exhausting and that I do not need it.	0.588
6	I enjoy solving puzzles or problems related to mathematics.	0.523
7	I feel intense fear of mathematics exams	0.546
8	I feel my heart beating rapidly while solving mathematics problems.	0.593
9	I find it difficult to do my mathematics homework	0.338
10	I am confident that I will obtain a good grade in a mathematics exam.	0.664
11	I feel that mathematics lessons are very long.	0.579
12	I feel annoyed when asked to review mathematics	0.626
13	I feel enjoyment when learning mathematic	0.688
14	I feel happy when the mathematics teacher is absent	0.570
15	I believe I do not have sufficient abilities to make progress in mathematics achievement	0.632
16	Mathematics makes me feel nervous	0.640
17	I feel anxious because mathematics is present in all areas of life.	0.851
18	I believe that learning mathematics requires extraordinary intelligence	0.459
19	I hate mathematics and cannot justify it.	0.695
20	I wish mathematics could be removed from my curriculum.	0.570
21	I feel upset when I see my classmates discussing a mathematics problem or lesson.	0.602
22	I feel tightness in my chest during mathematics class	0.682
23	I believe that I will not use mathematics in the future, so why should I study it?	0.641
24	I feel helpless in front of mathematics problems.	0.663
25	I feel tense when confronted with a mathematics lesson that I do not understand.	0.459
26	I feel annoyed when asked to solve a mathematics problem on the board in front of my classmates.	0.695
27	I feel afraid when asked to explain mathematical formulas	0.695
28	I fear unexpected mathematics quizzes.	0.581
29	I feel nervous when thinking about mathematics outside the classroom	0.665
30	I cannot follow the mathematics teacher when he explains a problem on the board	0.611
31	I feel disturbed when preparing for a mathematics exam	0.406
32	I feel embarrassed to raise my hand to ask a question in	0.455

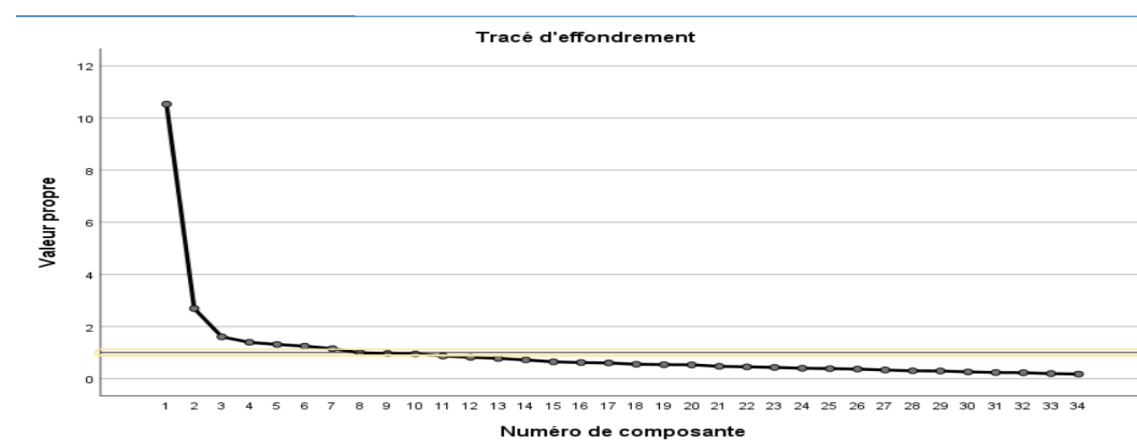
	mathematics class	
33	I feel anxious when I hear my classmate explaining a mathematics problem	0.566
34	I feel anxious when I encounter a mathematical formula in another subject.	0.458

Table No.04: Variance totale expliquée

Variance totale expliquée						
Composante	Valeurs propres initiales			Sommes extraites du carré des chargements		
	Total	% de variance	% cumulé	Total	% de variance	% cumulé
1	10,532	30,976	30,976	10,532	30,976	30,976
2	2,692	7,917	38,893	2,692	7,917	38,893
3	1,603	4,714	43,607	1,603	4,714	43,607
4	1,393	4,097	47,704	1,393	4,097	47,704
5	1,311	3,855	51,559	1,311	3,855	51,559
6	1,247	3,666	55,225	1,247	3,666	55,225
7	1,151	3,385	58,610	1,151	3,385	58,610
8	,992	2,916	61,526			
9	,964	2,837	64,363			
10	,946	2,783	67,146			
11	,867	2,551	69,697			
12	,818	2,406	72,103			
13	,775	2,280	74,383			
14	,718	2,112	76,494			
15	,646	1,899	78,394			
16	,616	1,812	80,206			
17	,601	1,768	81,974			
18	,552	1,624	83,599			
19	,536	1,578	85,177			
20	,528	1,554	86,731			

21	,472	1,389	88,120			
22	,452	1,330	89,450			
23	,431	1,268	90,718			
24	,398	1,170	91,888			
25	,383	1,127	93,015			
26	,366	1,076	94,091			
27	,331	,973	95,064			
28	,299	,879	95,943			
29	,293	,861	96,804			
30	,259	,762	97,566			
31	,234	,690	98,255			
32	,226	,664	98,919			
33	,192	,565	99,485			
34	,175	,515	100,000			

Based on the values presented in the table above, we observe that the eigenvalues of the components (factors) in the column titled "*Total*" indicate the presence of **seven** eigenvalues (factors) greater than **one**, which reflects the amount of variance extracted or explained by each factor.



Figur.01: Accumulation test to determine the number of dimensions of the scale

It is evident from the slope shown in the figure that there are **seven** eigenvalues greater than 1, while the remaining factors have eigenvalues less than 1.

We then performed factor rotation to determine the number of dimensions or factors to retain in the scale. We used the **orthogonal rotation method** to identify the appropriate factors.

The following table illustrates the **correlation matrix for the factor components after rotation**.

This is presented in **Table No. 05:**

Table No. 05: the correlation matrix for the factor components after rotation.

Matrice des composantes ^a							
	Composante						
	1	2	3	4	5	6	7
item19	,759						
item24	,716						
item30	,678						
item16	,675	-,309					
item20	,674						
item22	,658		-,420				
item17	,658				-,318		
item35	,653						
item11	,634						
item15	,623		,365				
item28	,613						
item23	,610	-,372			-,316		
item12	,606	-,301					
item34	,601						,301
item5	,583				,327		
item21	,580						,421
item27	,556				-,374	-,366	
item25	,535						
item9	,535						
item33	,530	,388	-,319				
item8	,528	,343					
item7	,522	,443					
item18	,520		,318				
item31	,443		-,346				

item32	,432					,320	
item3	,498	,639					
item4	,420	,627					
item2	,318	,489	-,359				
item13		-,323		,594			
item10		-,315		,509	-,323		
item6	,396			,402	,380		
item1	,495				,502		
item29	,470	,320				,488	
item14	,406					,335	-,510

Based on the values observed in the table above, we note that most of the items have heavily loaded onto the first factor, except for items **number 03 and 10**. The highest value for item 19 was **0.759**, and the lowest value for item 14 was **0.406**.

Thus, we will retain only **one factor**, making the scale **unidimensional**, and we will remove **items 13 and 10** from the final version of the scale.

Scoring Guide:

The scoring guide was developed considering the scale as a **criterion-referenced measure**, as follows:

In its final form, the scale consists of **one factor** containing **32 items**, where the **minimum score is 32**, and the **maximum score is 160**. This is illustrated in **Table No. 06**.

Table No. 06 Scale Correction Criteria

Scores	Level	Mathematics Anxiety
74 –32	Low	
117–75	Medium	
160 –118	High	

Conclusion

This study focused on the development of a **Math Anxiety Scale** using a rigorous scientific methodology. It began with defining the domain and formulating the items, and the initial version of the scale consisted of **38 items**. The scale then underwent a series of integrated psychometric procedures. The study started by verifying content validity through presenting the scale to specialists in **psychology** and **education**

sciences, followed by cognitive interviews with a sample of students to ensure the clarity of the items and their appropriateness for the students' level of understanding and perception of the trait being studied.

The statistical analysis, including the calculation of reliability coefficients and internal consistency, led to the exclusion of items with weak psychometric properties. Furthermore, the exploratory factor analysis revealed a **unidimensional factor structure** consisting of **32 items**, indicating that math anxiety represents a homogeneous psychological trait, revolving around intertwined **psychological**, **physiological**, and **behavioral** responses that are difficult to separate.

The final version of the scale demonstrated good psychometric properties, with a high overall reliability coefficient. The items showed acceptable loadings on the single factor, reflecting the scale's **construct validity**. Consequently, the scale can be relied upon as a precise diagnostic tool for determining levels of math anxiety among students at various educational stages, particularly at the **middle school level**. This scale is also considered a standardized scientific tool that contributes to the field of psychological measurement in **Algeria**, and it can be applied in practice to help **psychological** and **educational counselors** identify students with high levels of math anxiety, thereby facilitating the design of appropriate guidance and intervention programs.

The study recommends conducting further research to verify the psychometric properties of the scale on other samples with diverse demographic characteristics. It also suggests using the scale in correlational studies to explore the relationship between math anxiety and other variables, such as academic achievement and coping strategies. Additionally, it is recommended to develop reference standards for the scale that allow for the interpretation of scores and classification of different levels of exam anxiety.

In conclusion, this scale represents a significant addition to the diagnostic tools available to researchers and practitioners. It can contribute to a better understanding of the problem of math anxiety and how to intervene effectively to reduce its negative impact on students' academic performance and mental health.

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