MEASURES OF MATH ANXIETY AMONG SCHOOL-AGED STUDENTS

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Recognizing that math anxiety is a widespread phobia affecting academic behaviors, this paper conducted a thorough review of math anxiety measurements. Measurement scales used in math anxiety research among school-aged students are categorized into four types: self-reported questionnaires, interviews, observations, and biomarkers; with self-reported data being the predominant technique. This review also highlighted the variability among scales, inviting researchers to consider potential biases and measurement invariance when selecting measurement techniques. To enhance the precision of math anxiety assessments, future research could refer to measurement of general anxiety and explore mixed-method approaches.
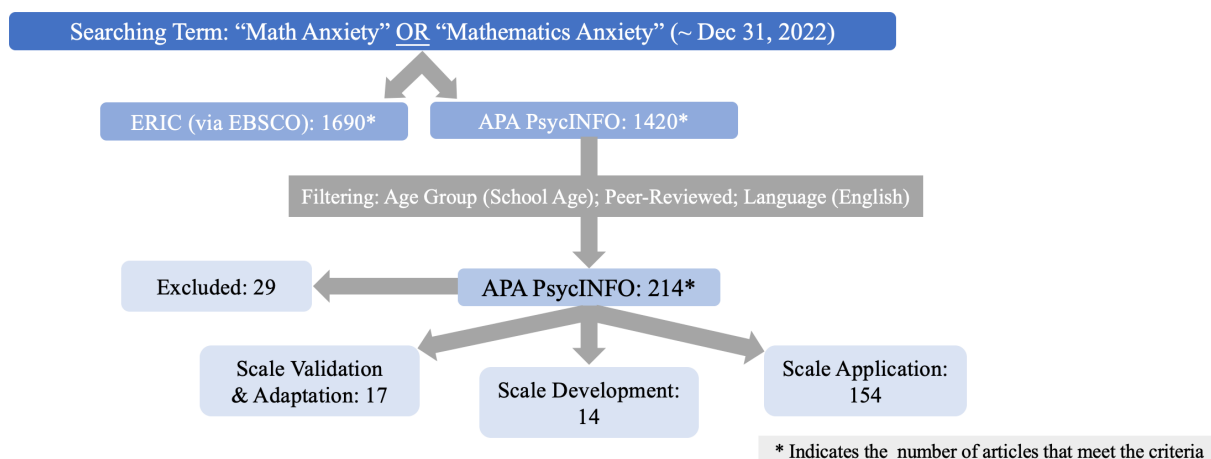
METHODOLOGY

Figure 1: **Method Flow**

This literature review was carried out in APA PsycINFO database (APA, 2023). A targeted search ensued for articles on "math anxiety" or "mathematics anxiety", limited to publications before December 31, 2022. To focus on school-aged students (ages 6 to 12 years), PsycINFO's filtering options were utilized, yielding 214 potential papers. Through manual filtering, articles that failed to meet the criteria were excluded, resulting in 185 relevant papers. These were then manually categorized into "Scale Development", "Scale Adaptation and Validation", and "Scale Application".

ANALYTICAL FRAMEWORK

This paper provides an overview on math anxiety measures, using the 5W framework (what, when, who, where, and why) as an analytical tool. Under the "what" category, the measurement name and data type are discussed, with self-report, behavioral, and informant data being the primary types of data collected. The "when" category covers the year of publication, which helps contextualize the development of the topic over time. Under the "who" category, author names and testing sample profiles are discussed, including age, sample size, and gender distribution. The "where" category

considers the research location or cultural background of a measure's first proposal. Lastly, the "why" category includes the conceptual framework and theoretical basis for each measure.

FINDINGS

Data type

147 out of 154 papers in the "Scale Application" category used self-report questionnaires as the only measurement for students' level of math anxiety. Among the questionnaires, the Abbreviated Mathematics Anxiety Scale (AMAS; Hopko et al., 2003), the Mathematics Anxiety Rating Scale for Elementary School Students (MARS-E; Suinn et al., 1988), the Mathematics Anxiety Rating Scale (MARS, 1972), and the Revised Math Anxiety Rating Scale (RMARS, 1982) are the four most popularly used ones. Detailed summary of each of them was carried out, and here is a figure that captures their genealogy.
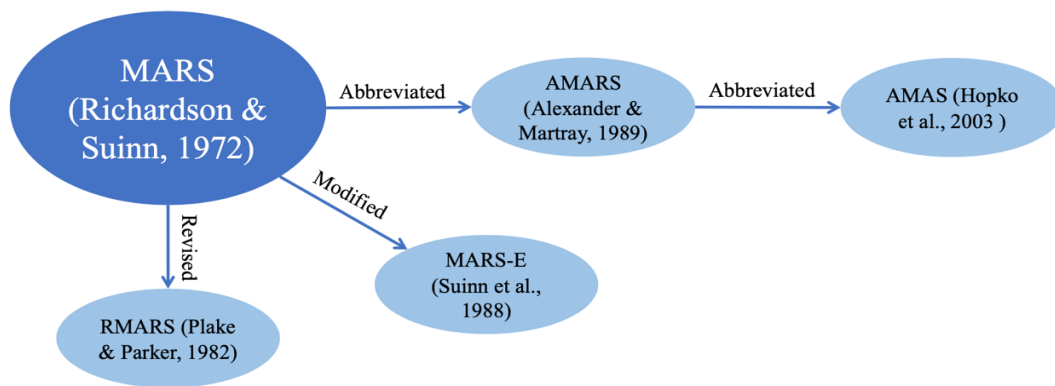

Figure 2: **Measurement Genealogy Map**

Regarding the remaining 7 papers, three of them utilized biomarkers (B-data) to assess math anxiety, and an additional three employed interviews (I-data). One paper centered on observations (O-data) as its primary data source, while another adopted a mixed-method approach, combining interviews (I-data) and observations (O-data) to gauge math anxiety. Here presents a summary of these papers in chronological order.

Year	Data Description	Data Type
1985	"a behavioral observation scale"	I-data
1987	interview and observation	Mix-method (S-data and I-data)
2012	"functional brain imaging data"	B-data
2015	"Functional MRI (fMRI)"	B-data
2015	"the physiological arousal measure of math anxiety obtained from the BCI device"	B-data
2018	"Math Anxiety Interview	I-data
2020	"Math Anxiety Interview"	I-data

Table 1: **Non-Questionnaire Data Overview**

Conceptual framework of math anxiety

The primary factors of math anxiety have been identified through the development of various measurement scales.

	MARS	RMARS	AMARS	MARS-E	AMAS
Math Test Anxiety	✓	✓		✓	
Numerical Anxiety (Calculation Anxiety)	✓	✓		✓	
Math Task Anxiety			✓		
Math Course Anxiety			✓		
Math Performance Adequacy Anxiety			✓		
Learning Math Anxiety					✓
Math Evaluation Anxiety					✓

Table 1: **Primary Factors of Math Anxiety**

Caution must be exercised when selecting a scale for research, as the concept of math anxiety differs between scales. For example, the MARS focuses little on math course anxiety, while the AMARS emphasizes it. The choice of measurement scale can bias research results when investigating the correlation between math anxiety and math class attendance rate.

Furthermore, it is essential to note that various terms, such as math motivation, math attitudes, numerical anxiety, and test anxiety, have been used interchangeably or as substitutes for math anxiety. However, Ashcraft and Krause (2007) have pointed out that these terms are not interchangeable. Hence, when conducting research in this field, it becomes crucial to carefully define and measure math anxiety to avoid confusion and ensure accurate findings.

External validity

An important concern relates to the external validity of math anxiety measurement scales, as they were developed in specific populations with varying characteristics. Students of different age groups may experience math anxiety differently due to differences in their levels of understanding and the specific math contexts they are facing. Future research should focus on validating these scales with diverse populations and considering their external validity to ensure accurate and reliable results.

Concerns regarding MARS

The Mathematics Anxiety Rating Scale (MARS) was the first scale developed to assess math anxiety and has been the basis for subsequent scales. However, MARS was developed on a sample of college students and did not observe gender differences in math anxiety. Subsequent research shows that gender is a significant factor in math anxiety, with women reporting higher levels of

math anxiety than men. This raises doubts about the validity of MARS and the potential bias it may introduce, given that it serves as the basis for many math anxiety measurement scales.

CONCLUSION

The Research Domain Criteria (RDoC) framework (NIMH, 2009) is developed to guide research into the underlying neural and behavioral mechanisms of mental illness. The framework is based on the idea that mental illnesses are complex and cannot be fully understood by categorizing them based on observable symptoms alone. It can be applied to measure math anxiety, by analyzing changes in blood flow, physiological responses, behavioral performance, and subjective experiences related to math anxiety.

This literature review provides a comprehensive overview of math anxiety measurement among school-aged students, highlighting its complex nature. Continuous attention and research on this topic are necessary to improve the accuracy of measurement methods.

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