A SYSTEMATIC LITERATURE REVIEW ON THE EFFECT OF MATH ANXIETY TOWARDS MATH PERFORMANCE AND ACHIEVEMENT

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Abstract
Anxiety is one of the factors that is believed to affect performance and achievement in learning subjects. However, the belief is still debatable. The fact that many students around the world consider that mathematics is a difficult subject. This study explores the effects of math anxiety towards math performance and math achievement. By understanding this connection, it is expected that the teacher will be able to take appropriate steps in teaching mathematics. This study used the Systematic Literature Review (SLR) method, 15 articles were sorted and selected based on the required criteria, the data taken from the Google Scholar database, within search strings from 2019 to 2023. The results showed some points that the math anxiety scales used depending on the participant's characteristics in each study, 8 main factors driving the emergence of math anxiety and math anxiety affects math performance and achievement, especially at higher grade levels.

Keywords: *SLR, Math Anxiety, Math Performance, Math Achievement*

Introduction

Anxiety in learning is believed to affect one's effectiveness in thinking or doing something. Anxiety is a psychological element that describes a state of feeling, emotional state, worries, uncertainty, or fear of reality that is owned by a person when facing reality or events in his life. According to the American Psychological Association (APA), anxiety is an emotion which affects physical change in terms of increasing blood pressure, characterized by tension and worries.

Mathematics is one of the subjects that is still considered difficult by most students of all ages, especially in Indonesia. This makes mathematics a frightening spectre for some of them. During mathematics teaching and learning activities, there are still many students who complain, feel anxious, worried and even unsure about starting the lesson. A study conducted by Aguilar (2021) found that high school students in Mexico have the difficulties with math since elementary, the math anxiety was a new thing for them. This fear of mathematics can be interpreted as math anxiety.

Math anxiety is a form of the emotional response of students when studying mathematics, listening to teachers, solving math problems, and discussing mathematics. Therefore, it can be concluded that math anxiety is an emotional reaction in the form of feelings of fear, tension and anxiety when it comes to math, manipulation of numbers or numbers.

The general attitude that emerges when students are in that situation will reflect how they feel. For example, if a student says "I like math because it is difficult", it means he is expressing his attitude about math. Attitude is related to mental alertness, such as the formulation which states that attitude is mental alertness that is managed through background, which has a certain influence on one's acknowledgement to people, matter or circumstances related to it.

Math anxiety is believed to affect students' math performance and achievement. Basically, according to studies, students' learning outcomes in mathematics are influenced by several factors, including students' attitudes towards mathematics, self-concept and student anxiety in learning. Attitudes are evaluative statements either desirable or undesired about objects, people or events. Attitudes that arise as a result of math anxiety by feeling uncomfortable or having difficulties in the process of learning mathematics will affect their math performance and math achievement. This prompted the authors to conduct a systematic literature review related to the influence of math anxiety on students' math performance and math achievement. The purpose of this study is to find out what dominant instruments are used in studying math anxiety, the factors that encourage the emergence of math anxiety and the effects of math anxiety towards math performance and achievement.

Method

The object of the research

The object of this research is math anxiety. Taking math anxiety as an object of research has several reasons as follows:

1. Anxiety in learning is believed to affect students' math performance or achievement.
2. There is a tendency for students to think that mathematics is a difficult subject.
3. Instruments to measure the math anxiety of learners are miscellaneous.

Research Questions

Research questions are formulated following the matters that the researcher wants to find related to the selected topic. The research questions in this current study are as follows:

RQ1. What instruments are used to measure students' math anxiety from 2019-2023?

RQ2. What are the factors behind the emergence of math anxiety?

RQ3. How does math anxiety affect student mathematics learning outcomes (performance and achievement)?

Search Process

The search process is carried out to obtain relevant data according to the topic being studied to answer research questions. The search process is carried out using the search engine.

Criteria

At this stage, the author determines which sources are eligible as sources in this SLR. The following criteria are required to be selected as data sources:

1. Data used in the frame 2019–2023.
2. Data obtained through the site https://scholar.google.com/
3. Data related to math anxiety toward math performance and performance.

Quality Assessment

Evaluation is conducted through a process of quality assessment by matching the data sources with the following criteria.

QA1. Are the paper journals published in 2019-2023?

QA2. Do the paper journals write about the factors of the emergence of math anxiety?

QA3.Do the papers the journals write about math anxiety and math performance/ achievement?

From each paper, will be given a value answer below for each question above; Y (Yes) and T (No).

Data Collection

Data collection in this study includes primary and secondary data.

Primary data is the journals collected from the site 'Google Scholar' under some consideration, as follows:

1. Google Schooler provide complete facilities for search.
2. It provides the adjusted feature to filter sources: based on year range and topics.

Secondary data is a complement to primary data, for example only abstract is available then secondary data is needed through deeper search on Google. Several stages should be passed, including observation and study of literature.

Assessing the data based on the SLR method

The articles are filtered by year range and relevancy, the researchers chose the years 2019–2023 to find the related issues. After clicking the filter, the titles, year of publication, and author's name will be displayed. The results displayed by the search process are 428 journals, which can be seen in Figure 1.

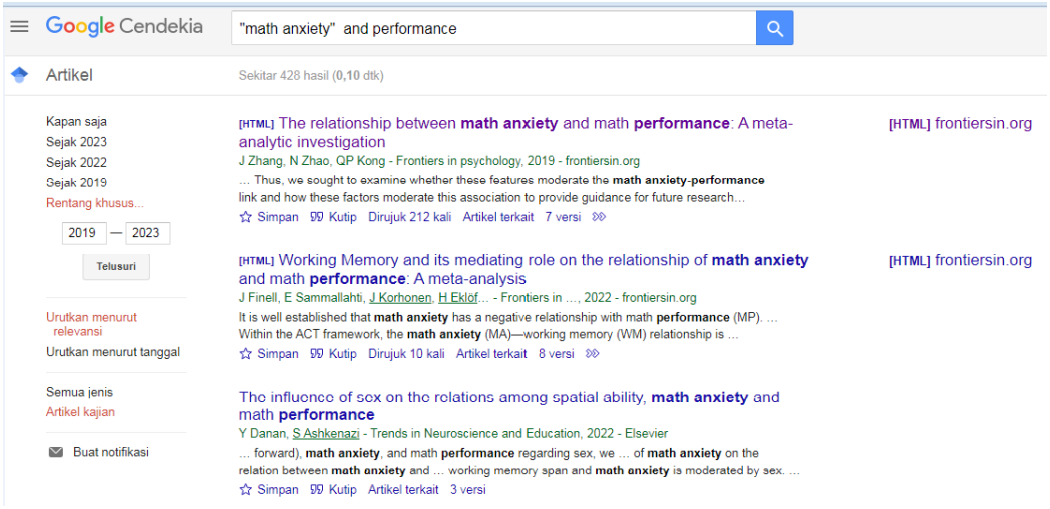

Figure 1. The Results of Filtering Year Range and Relevancy

Data Analysis

The collected data has been analyzed which shows:

1. The instruments used to measure students' math anxiety from 2019-2023 (referring to RQ1).
2. The factors driving the emergence of math anxiety (referring to RQ2).
3. The effect of Math Anxiety on learning outcomes (referring to RQ3).

Data was obtained through a search database, Google Scholar. The 428 articles are still sorted based on the keywords on the title, and the title with the nuance of math anxiety relation to math performance and achievement remained. Then, the articles are been through quality assessment with three questions. After duplicate removal. 15 articles are included.

Results and Discussion

Results

Show the result of the research. Differentiate results and discussion. The discussion involves a comparison with other research findings.

Table 1. The Selected Journals from the Search

No.	Journal Type	Quantity
1.	Learning and Individual Differences, Volume 70, February 2019	1
2.	American Psychological Association, Psychological Bulletin, Volume 147(2), 2019	1
3.	Front. Psychol., 07 August 2019, Sec. Educational Psychology, Volume 10 – 2019	1

No.	Journal Type	Quantity
4.	International Journal of Education in Mathematics, Science and Technology (IJEMST), Volume 8 (3), 2020	1
5.	Educational Psychology Review Volume 34: 363-399, 2021	1
6.	Current Psychology, A Journal for Diverse Perspectives on Diverse Psychological Issues, Volume 41 (1) (2022)	1
7.	Social Psychology of Education, An International Journal Volume 26 (1), 2023	1
8.	Journal for the Education of Gifted Young Scientists, Volume 8(1), 271-290, March 2020	1
9.	International Electronic Journal of Elementary Education, Volume 11 (5), 2019	1
10.	Indonesian Journal of Information Systems (IJIS) Vol. 1, No. 2, 2019	1
11.	Multi-Knowledge Electronic Comprehensive Journal for Education and Science Publication, Issued (57) 2022	1
12.	BMC Psychology; London Volume. 9, 2021	1
13.	PLoS ONE, Volume 14(1), 2019	1
14.	ZDM- Mathematics Education, Volume 55 (2023)	1
15.	International Journal of Education in Mathematics, Science and Technology, Volume 8(3), 2020	1

Results of the search process will be selected based on boundary and entry criteria (inclusion and exclusion criteria). This process leaves 15 article journals, then carried out in data scanning. Table 2 shows the results of the quality assessment to show whether the data is used or not in this study.

Table 2. Quality Assessment

No.	Author	Title	Year	QA1	QA2	QA3	Results
1.	SL Lukwoski, Jack Dicktrapani, Jeon Minjeong, Zhe Wang, et.al.	Multidimensionality in the measurement of math-specific anxiety and its relationship with mathematical performance	2019	Y	Y	Y	V
2.	Connie Barroso, Colleen M. Ganley, Amanda L. McGraw, et.al	A Meta-Analysis of the Relation Between Math Anxiety and Math Achievement	2020	Y	Y	Y	V
3.	Jing Zhang, Nan Zhao and Qi Ping Kong	The Relationship Between Math Anxiety and Math Performance: A Meta-Analytic Investigation	2019	Y	Y	Y	V
4.	Nadide Suren, Mehmet Ali Kandemir	The Effects of Mathematics Anxiety and Motivation on Students' Mathematics Achievement	2020	Y	Y	Y	V

No.	Author	Title	Year	QA1	QA2	QA3	Results
5.	Sara Caviola, Enrico Toffalini, David Glofre, et. al.	Math Performance and Academic Anxiety Forms, from sociodemographic to Cognitive Aspects: A Meta-analysis on 906,311 Participants	2021	Y	Y	Y	V
6.	Marija Zivkovic, Sandra Pellizzoni, Irene C. Mammarela, Maria Ciara Passonglunghi	The relationship between Math Anxiety and Arithmetic Reasoning: The mediating Role of Working Memory and Self Competence	2022	Y	Y	Y	V
7.	Marija Zivkovic, Sandra Pellizzoni, Eleonora Doz, et.al.	Math Self-efficacy or Anxiety? The Role of Emotional and Motivational Contribution in Math Performance	2023	Y	Y	Y	V
8.	Sophia C. Weissgerber, Chawwah Grunberg, Luisa Neufeld, et. al.	The Interplay of Math Anxiety and Math Competence for Later Performance	2022	Y	Y	Y	V
9.	Dwi Juniati, Ketut Budayasa	Working Memory Capacity and Mathematics Anxiety of Mathematics Undergraduate Students and Its Effect on Mathematics Achievement	2020	Y	Y	Y	V
10.	Yilmaz Mutlu	Math Anxiety in Students with or without Math Learning Difficulties	2019	Y	Y	Y	V
11.	Noura Hussein Suleiman Abusalih	The Significance of the Psychological Factor in Mathematics Educational Process and Its Impact on Students' Academic Performance	2022	Y	Y	Y	V
12.	Eihab Khaswneh, Cameron Gosling, Brett Williams	What Impact of Math Anxiety Have on University Students?	2021	Y	Y	Y	V
13.	Kenny Skagerlund, Rickard Ostergen,	How does mathematics anxiety impair mathematical abilities?	2019	Y	Y	Y	V

No.	Author	Title	Year	QA1	QA2	QA3	Results
	Daniel vastfjall, Ulf Traff	Investigating the link between math anxiety, working memory, and number processing					
14.	David W. Putwain, Peter Wood	Anxiety in Mathematics Classroom: Reciprocal relation with Control and Value, and relation with Subsequent Achievement	2023	Y	Y	Y	V
15.	Nadide Suren Mehmet Ali Kandemir	The Effects of Mathematics Anxiety and Motivation on Students' Mathematics Achievement	2020	Y	Y	Y	V

Discussion

In this study, we aim to find out what instruments are dominantly used in measuring math anxiety, what factors drive the emergence of math anxiety and how the effects of math anxiety math towards performance and achievement using a systematic literature review method. Our goal is devoted to explaining more clearly the findings of researchers in the last five years regarding math anxiety and its effect on performance and achievement.

RQ1. What instruments are used to measure students' math anxiety from 2019-2023?

In total, there are 428 journals sorted through a search process. After the data is selected based on inclusion and exclusion criteria using keywords "Math Anxiety and performance". From the results of the Quality Assessment (QA), there are 15 relevant journal articles to be selected to answer the research questions. The answer to RQ1 is shown in Table 3. It shows math anxiety measurement instruments used in the studies, as follows:

Table 3. Math Anxiety Scale

No.	Instrument	Quantity
1.	Math Anxiety Rating Scale – Elementary (MARS-E)	2
2.	Scale for Early Mathematics Anxiety (SEMA)	1
3.	Math Anxiety Scale for Young Children (MASYC)	1
4.	Children's Math Anxiety Questionnaire (CMAQ)	1
5.	Math Anxiety Questionnaire (MAQ)	1
6.	MARS (Mathematics Anxiety Rating)	1
7.	AMAS (Abbreviated Math Anxiety Scale)	3
8.	Anxiety Scale for Elementary School Students (MASESS)	2
9.	The Revised Children's Manifest Anxiety Scale-Second Edition (RCMAS)	2
10.	Mathematics Anxiety Scale-UK (MAS-UK)	1

As shown in Table 3, the dominant instruments used are AMAS (Abbreviated Math Anxiety Scale) 3 times, Anxiety Scale for Elementary School Students (MASESS), Math Anxiety Rating Scale-Elementary (MARS-E) and Revised Children's Manifest Anxiety Scale-Second Edition (RCMAS) 2 times each. The choice of instrument mostly adjusted to the characteristics of the participants in the studies, such as the grade levels of the participants.

RQ2. What are the factors behind the emergence of math anxiety?

From the results of the Quality Assessment (QA), there are 15 relevant journal articles to answer the RQ2. Several factors trigger the emergence of math anxiety in learners. The results are shown as follows:

1. Numerical operation

   Math anxiety learners emerge when performing number operations usually in the four main operations, including addition, subtraction, multiplication, and division in mathematics.

2. Classroom situation

   The enjoyment that is built into the process of teaching mathematics such as teachers' enjoyment, response and creative teaching style affect students' positive attitude towards math, under contrasting conditions, and vice versa drives math anxiety.

3. Mathematic test

   Learners are stressed out or fear of doing math tests. It overwhelms learners' working memory while answering the test.

4. Culture

   Sort of culture in which society highly values student academic achievement as an indicator of future success, for example, the majority of parents in certain areas send their children to have private tutoring after school even when there is intense competition at school. Learners tend to adopt this mindset which leads to anxiety.

5. Learning difficulties

   There are various math learning problems such as trouble in memorizing math operations, weak in arithmetic, turning symbols into concrete materials, figuring out visual-spatial aspects of math, etc.

6. Working memory

   Working memory processes enable the learner to complete the simplest math tasks such as comparing numbers or single or math performance in multi-digit math or arithmetic

7. Reasoning Ability

   Math reasoning is a process of applying logical thinking to a situation to derive appropriate problem-solving strategies for a given question and using these methods to develop and explain solutions using math.

RQ3. How does math anxiety affect student mathematics performance and achievement?

From the results Quality Assessment (QA) there are 15 relevant journal articles to answer the RQ3, math anxiety affects student mathematics performance and achievement in many ways, as follows:

1. Math anxiety levels of students taking private tutoring were higher than those who did not because they had a higher standard of achievement than the ones who did not.
2. Math anxiety towards performance is affected by learners' gender and female math anxiety tends to influence their performance negatively than males.
3. There is a direct effect of math anxiety on math performance but depending on the task type.
4. There is a direct influence of math anxiety on math performance with a significant and positive influence on visual working memory.
5. Calculation anxiety was negatively related to math performance but classroom situations and tests.
6. Math anxiety was negatively correlated with math abilities.
7. The level of math anxiety of the students with math learning difficulties does not differ with the low achievers.
8. A significant relation between math anxiety and math achievement or can be predicted achievement at a higher level (post-secondary to adulthood)
9. Asian students tend to have more anxiety in learning math which affects their performances and achievement. Meanwhile, European and American students show less anxiety.
10. Competent pupils with higher levels of mathematics anxiety get lower achievement.
11. Students who were daily in contact with mathematics did not make their math anxiety low and supported their math achievement.

Some of the points that have been summarized from analyzing 15 articles related to the effects of math anxiety on math performance and achievement still need to be studied further. More specific and in-depth studies are recommended, scope it by specific region or age of learners.

Conclusion

Based on the results of the research that has been done, several conclusions can be drawn as follows:

1. The instrument used to scale math anxiety varies depending on the participant's grade levels.

2. The dominant factors driving the emergence of math anxiety are numerical operation, classroom situations, mathematic tests, culture, learning difficulties, working memory, and reasoning ability.
3. Math anxiety affects learners' math performance and achievement, especially at higher grade levels.

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