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*Driving Research Towards Excellence*

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## MATHEMATICS ANXIETY: A BIBLIOMETRIX ANALYSIS

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Mathematics anxiety is defined as a feeling of tension and apprehension that interferes with math performance ability, the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situation. In this study, a bibliometric analysis are used to evaluates the mathematics anxiety. Through the use of bibliometrix, this paper investigates the amount of studies conducted in the field of mathematics anxiety, identify the development status and the leading trends in term of publication, document types, cited document, authors and production countries. This study intended to fill a gap in the range of bibliometric studies on mathematics anxiety produced to date, which have been concentrated in only a few publications, and for the part have approached the issues in a general manner. The analysis and the graphical presentation can help both researchers and practioners to better understand the state of the art of mathematics anxiety.

**Keywords:** Mathematics anxiety, Bibliometric, Bibliometrix

### 1. Introduction

Mathematics is a subject taken very seriously throughout the educational system, regardless of country or level of education. It is necessary to learn mathematics in order to acquire knowledge and skills for daily life. Mathematics also teaches students to solve problems, develop new ways of thinking, and plan for the future. Preconceived notions about mathematic shape students' perceptions of mathematics. The anxiety in mathematics is spark due to difficulties in mathematics comprehension, which is a dynamic process that involves both mathematical structures and actions. Mathematics anxiety is a global phenomenon that has generated research interest over the past four decades.

As a definition, mathematics anxiety is defined as an uncomfortable feeling experienced or experience of negative affect when performing a mathematical task and activity, which is seen as an obstacle to learning mathematics. Most of published papers deal with the topic of mathematics anxiety among students (Nordin et al., 2015; Ko and Yi, 2011) which some discussed about factors influence and the effects of mathematics anxiety to students (Woodard, 2002). For students, mathematics anxiety is significantly effect students motivation (Zakaria and Nordin, 2008) and achievement (Kyttälä and Björn, 2010; Rameli et al., 2014; Suren and Ali Kandemir, 2020). There are frequent reports that mathematics anxiety raises some issues related to mathematics performance. In a study by Juniati and Budayasa (2020), the higher the level of mathematics anxiety, the lower the mathematical achievement. In another study by Jamieson et al. (2020), students with higher levels of mathematics anxiety are associated with students perceiving more demand and fewer coping resources in exam settings and getting worse exam performance. Some students emphasized that the fear of success and stress also contribute to mathematics anxiety (Cumhur and Tezer, 2019). Another study found that mathematics anxiety is related to poor mathematical competence (Ching et al., 2020) and the learning environment (McMinn and Aldridge, 2020), which affect students' confidence, motivation, and achievement (Hlalele, 2019). However, the reasons for mathematics anxiety can vary from individual to individual (Aydın and Aytakin, 2019).

Many methods used by researchers to determine the anxiety of mathematics. Richardson and Suinn (1972) construct a hierarchy of mathematics anxiety by allowed respondents rates themselves on the amount of anxiety aroused by each item in 98 scale items of Mathematics Anxiety Rating

Scale (MARS). There were other measurement than MARS used to measure Mathematics Anxiety such as Revised Math Anxiety Rating Scale (RMARS) (Nordin et al., 2015; Wilson, 2012) and The Abbreviated Math Anxiety Scale (AMAS) (Livingstone and Carl, 2012).

This study undertake the past literature of mathematics anxiety and performs a bibliometric analysis. The objective of this study is to analyse the literature and identify the top productive authors, top countries, top keywords used in literature, citation analysis and sources related to mathematics anxiety. In particular, there has been sustained research activity in mathematics anxiety over the last three decades, but it has received relatively little attention. Until recently, no research on the patterns of students' mathematics anxiety had been conducted. Therefore, this study is intended to fill a gap in the range of bibliometric studies on mathematics anxiety produced to date, which have been concentrated in only a few publications, and, for the most part have approached the issues in a general manner.

## 2. Methodology

The articles used in this study are extracted from the Scopus database. Traditionally, Scopus database is among the most widely used database for bibliometric analyses and considered as one of the largest database covering scientific journals, books, article, conference proceeding and etc. The articles used in this analysis are searching using title and keyword search. In advanced keyword, only keyword of "Mathemathic Anxiety", "Mathematics", "Student" and "Anxiety" are included in searching articles from the year 1994 until year 2021. The final search identified 166 relevant documents related to the according keywords.

Then, the documents collected was analysed by using a bibliometric analysis tool called bibliometrix (Aria and Cuccurullo, 2017). More precisely, a shiny interface for bibliometrix called biblioshiny the web-based interface of R-package are used as a tool. Bibliometrix and Biblioshiny were developed by the Italian scholar Massimo Aria in the R language environment. Both the Bibliometrix and Biblioshiny packages are open source and free. The difference between the two packages is that Bibliometrix's operating mode consists of code commands and Biblioshiny uses the shiny package to encapsulate the core code of Bibliometrix and create a web-based online data analysis framework. Biblioshiny allows user to perform relevant bibliometric analysis and visual analysis with an interactive web interface.

Based on the Bibliometrix and Biblioshiny software package, this study obtains bibliometric indicators such as publication volume, citation count and high-frequency keywords.

## 3. Result

In this sections below, present the finding of bibliometric analysis in Mathematics Anxiety.

### 3.1 Main documents in Mathematics anxiety

Table 1 shows the primary information about the dataset extracted from Scopus containing papers dealing with Mathematics anxiety. In the table, all 166 documents are articles journal published from 1994 until 2021.

### 3.2 Annual scientific production and key sources annual scientific production

Figure 1 presents the yearly scientific production of document on mathematics anxiety from 1994 until beginning 2021. From that figure, only one paper published during the year 1994, 1996, 2001 and 2002. The first clear jump in mathematics anxiety publication occurred in 2006 with 3 documents, then the number of publication reached 15 document in 2014. Since then, the number of document published on mathematics anxiety and available in the Scopus database was kept above 10, with a pick in 2020 (34 documents).

The top 10 most frequent journals published articles on Mathematics anxiety shown in Table 2. It is shown that the journal of *Frontier in Psychology* is topping the list with 14 documents published, as it appears in the Scopus database. The journal was launched to review and publish papers across all psychological sciences (Frontiers in Psychology 2021). The *Learning and Individual Differences* comes second with 13 documents, then the *Procedia-Social and Behavioral Sciences* with 11 documents, followed by the *Psychological Reports* with 9 documents published. The *Journal of Physics: Conference Series* stands at the fifth position with 7 documents.

Table 1: Main Information about document published on Mathematics Anxiety in Scopus Database.

Description	Results
<b>MAIN INFORMATION ABOUT DATA</b>	
Timespan	1994:2021
Sources (Journals, Books, etc)	113
Documents	166
Average years from publication	5.66
Average citations per documents	15.11
Average citations per year per doc	1.883
References	7859
<b>DOCUMENT TYPES</b>	
Article	166
<b>DOCUMENT CONTENTS</b>	
Keywords Plus (ID)	273
Author's Keywords (DE)	450
<b>AUTHORS</b>	
Authors	398
Author Appearances	448
Authors of single-authored documents	33
Authors of multi-authored documents	365
<b>AUTHORS COLLABORATION</b>	
Single-authored documents	36
Documents per Author	0.417
Authors per Document	2.4
Co-Authors per Documents	2.7
Collaboration Index	2.81

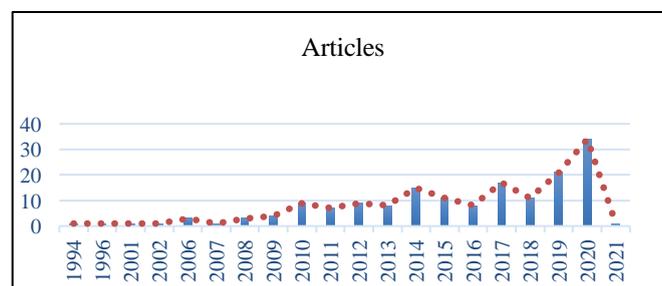


Figure 1: Annual publication trends

### 3.3 Top 10 authors based on the number of papers

Regarding the top authors in relation to number of articles, Table 3 show the top 10 most productive authors on Mathematics anxiety in the Scopus database, related to their articles output. We can see that frequent journals published articles on Mathematics anxiety shown in Table 3. It is shown

Mamarella, I.C leads the race with 6 articles, followed by Caviola, S. with 5 articles, Balolu, M. with 4 articles. Then, Dowker, A., Fernandez, L.M, Nez\_Pea Mi and Suárez-Pellicioni with each 3 articles hold the ranks 3th to 7th. Three authors (Alamolhodaei, H., Birgin, O. and Bjrnm, P.M.) having published each 2 articles hold the position 8th to 10th and close the top 10 list

Table 2: Top 10-Most frequent journals.

Sources	Articles
Frontiers In Psychology	14
Learning And Individual Differences	13
Procedia - Social And Behavioral Sciences	11
Psychological Reports	9
Journal Of Physics: Conference Series	7
Contemporary Educational Psychology	6
PLOS One	6
Understanding Emotions In Mathematical Thinking And Learning	5
Educational Studies In Mathematics	4
Eurasia Journal Of Mathematics Science And Technology Education	4

Table 3: Top 10-Most productive authors.

Authors	Articles	Authors	Articles Fractionalized
Mamarella, I.C	6	Mamarella IC	1.40
Caviola, S.	5	Caviola S	1.15
Balolu, M.	4	Balolu M	2.25
Dowker, A.	3	Dowker A	0.92
Fernandez, L.M	3	Maloney EA	0.87
Nez-Pea Mi	3	Nez-Pea Mi	0.92
Surez-Pellicioni M	3	Surez-Pellicioni M	0.92
Alamolhodaei H	2	Alamolhodaei H	1.25
Birgin O	2	Birgin O	0.58
Bjrn PM	2	Bjrn PM	1.00

### 3.4 Top 10 most cited paper

The distribution of the most globally cited documents is shown in Table 4. It indicates that the study (Gervais et al., 2010) has the highest total citation (110) based on Scopus database, followed by (Maloney et al., 2011) with 106 citations. The third position occupied by (Vukovic et al., 2013) with 102 total citations. The paper by Sarkar et al. (2014) is at the fourth position based on total citation count (98), while Hoffman (2010) are ranked with 90 total citations at the fifth position.

Table 4: Top 10-Most cited papers.

Paper	Total Citations	TC per Year
Gervais SJ, 2010, Psychol Women Q	110	9.1667
Maloney EA, 2011, Q J Exp Psychol	106	9.6364
Vukovic Rk, 2013, Contemp Educ Psychol	102	11.3333
Sarkar A, 2014, J Neurosci	98	12.25
Hoffman B, 2010, Learn Individ Differ	90	7.5
Jain S, 2009, Contemp Educ Psychol	80	6.1538

Vinson Bm, 2001, Early Child Educ J	80	3.8095
Balolu M, 2006, Pers Individ Differ	78	4.875
Stankov L, 2014, Educ Psychol	67	8.375
Zakaria E, 2008, Eurasia J Math Sci Technol Educ	62	4.4286

### 3.5 Mathematics anxiety 10 most cited country

Table 5 point out that obviously USA comes first with the highest total citations count (26), followed by Turkey with 14 total citations, Australia with 9 total citations and Italy and Malaysia with each 6 total citations. All the remaining top countries of this top 10 list have a total citation 5 and below.

Table 5: Top 10-Most productive countries (based on first authors's affiliation)

Country	No. of Articles	% of Articles
USA	26	20.0
Turkey	14	10.8
Australia	9	6.9
United Kingdom	8	6.2
Italy	6	4.6
Malaysia	6	4.6
Germany	5	3.8
South Africa	5	3.8
Spain	5	3.8
China	4	3.1

### 3.6 The 10 most frequent word related to Mathematics anxiety

Table 6 highlights the most frequent keywords used by authors in their publications, the word with the highest number of occurrences being mathematics anxiety (165). This related to the keyword search in Scopus database. Then, the second word with the highest number of occurrences is mathematics achievement (20), followed by working memory (11), self efficacy (8) and gender, mathematics education and test anxiety with each 7 occurrences. All the top five positions may illustrate the issues related to mathematics anxiety.

Table 6: Top 10-Most frequent keywords

Authors Keyword (DE)	No. of articles	Keywords-Plus (ID)	No.of articles
mathematics anxiety	165	anxiety	40
mathematics achievement	20	mathematics	36
working memory	11	female	27
self-efficacy	8	human	25
gender	7	male	24
mathematics education	7	article	16
test anxiety	7	adult	14
mathematics performance	6	adolescent	13
achievement	5	humans	12
mathematics	5	anxiety	40

#### 4. Contributions

From the academic contributions, our results showed in recent years there are increasing trends of article published in this topics. Therefore, our work hopefully can provides an insights for pratitioner regarding Mathematics anxiety issues.

#### 5. Limitations

As the main limitations of this study, since we used an advanced keyword of mathematics anxiety and mathematics for the search and limit to article journal as document type, we cannot ensure that we covered all published papers. In the same thought, the choice for a database, in this case, Scopus, could limit the search.

#### 6. Conclusion

There are a lot of mathematic anxiety studies done to help students dealing with numbers and solving mathematical problems. The increasing number in publication related to this topic shows that there are a lot of changes in the measurements and findings, which need to be discussed by researchers.

This study is done to help researchers in finding the latest trend on mathematic anxiety study by using bibliometric analysis. Scopus database was used for the analysis with the limitation of journal articles as the document type. The analysis determined the most frequent journal that published the related articles, productive authors, top authors with most cited articles, top country producing related articles and top related keyword as references for other researchers by analysing articles from Scopus database.

By having this information, new researcher may gather important findings and latest trend on mathematic anxiety by referring to the top cited articles, top journal and top authors. Research may be easier than searching randomly by using the keyword by having the ranking on the subject matter.

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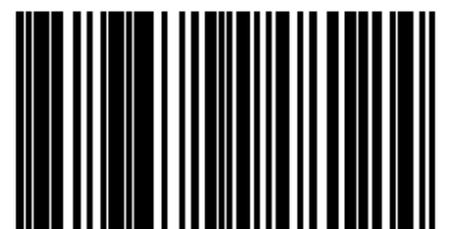
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