

Bibliometric analysis of learning mathematics studies from Indonesian authors

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Abstract

The concept of learning mathematics in schools has evolved to mean learning to participate in mathematical practices. In the 20th century, math education research developed, but each key issue and approach offers many questions. For the purpose of this inquiry, the Bibliometrics Analysis was carried out. When performing research on bibliographic material and carrying out citation analysis of each article published in scientific journals and other types of scientific literature, researchers could find it beneficial to use bibliometric analysis. This is a quantitative descriptive research. Researchers want to investigate the evolution of mathematics learning research outcomes in Indonesia, the distribution pattern of publications based on research affiliations, research themes, and scientific journals in Scopus. This study presents findings that are exploratory in nature from research on mathematics education in Indonesia. This study investigates the central body of scientific work in the subject of mathematics learning with the goal of providing information to educators, lecturers, and institutions of higher education about the current state of research trends in the field of mathematics learning. The data indicate that there has been less study conducted on mathematical education during the past two years. At the present time, the Universitas Pendidikan Indonesia is the association with the most significant influence. When it comes to publications, the Journal of Physics: The Conference Series has more mathematics learning research articles than any other Scopus-indexed journal.

Keywords: Bibliometric, Biblioshiny, Mathematics, R, Scopus

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INTRODUCTION

According to an articles that was authored by (Esmonde, 2009), the concept of learning mathematics in schools has evolved to mean learning to participate in mathematical practices. In other words, students are taught to form representations, make arguments, reason about mathematical objects, explain their ideas, develop proofs, and a variety of other mathematical skills (Schoenfeld, 2002). There is a wide variety of approaches of teaching mathematics that have been implemented at academic institutions. Dienes' theory is one of them; it is a hypothesis about learning mathematics that comprises four principles.

According to (Dienes, 1960), promoting mathematical experiences that lead to the discovery of mathematical structures requires four conditions. First, the construction principle implies that mathematical relations result from the abstraction of physical and mental operations on manipulable things. An individual can identify mathematical similarities by altering the contexts, situations, and frames in which isomorphic structures emerge. Despite appearances, the Dynamic Principle asserts that model transformations are isomorphic. The Perceptual Variability Principle advises including perceptual distractors while presenting problem scenarios, i.e., altering the perceptual particulars of the problem while retaining certain structural similarities (Sriraman & English, 2005). Technology is ubiquitous these days. Modern technology is widely used in math instruction. Math teachers can better engage students by making the topic interesting and including them in the learning process (Nasution, 2018).

In the 20th century, math education research developed, but each key issue and approach offers many questions. To investigate math learning, we must look at how students acquire mathematical concepts and solution procedures, and we must watch and analyze instruction-acquisition interactions. Indeed, constructing a theory of learning from instruction using the intervention technique requires a strong methodology for designing teaching experiments in complicated educational environments so that theoretically viable inferences may be drawn from the empirical data (Corte, 2004).

One method for conducting a search for empirical data on the dynamics of mathematics learning problems is to conduct an analysis of the bibliography of articles, books, and reviews that have been published by academics as part of their research in reputable international journals such as Scopus and Web of Science. The term for this technique is bibliometric analysis. Utilizing this methodology, one is able to quantitatively assess the expansion and evolution of scientific knowledge as well as perceive it.

For the purpose of this inquiry, the Bibliometrics Analysis was carried out. When performing research on bibliographic material and carrying out citation analysis of each article published in scientific journals and other types of scientific literature, researchers could find it beneficial to use bibliometric analysis. In their work, researchers are able to make use of a wide variety of information that may be found in bibliographies, such as the type of publication and the language used to help with bibliometric evaluations (Hamidah et al, 2020). The term "bibliometrics" was first used as a statistical measurement in 1969 by (Pritchard, 1969), who also gave it its current name. It is utilized in the research of both the quality and quantity of works that have been published. After the term was first coined, the primary focus of bibliometric indicators was on the counting of several methods that might be used to evaluate the quality of research. This persisted during the first few decades after the phrase was initially put into use (Raaijmakers, 1999).

For some decades now, bibliometric studies have been at the forefront of the literary world, largely because of the advancements they have made in bringing attention to various fields of study (Cancino et al., 2017). The method of bibliometric analysis in mathematics education has been the subject of extensive research as of lately (Julius et al., 2021). The study aims to give empirical data on the geographical spread of mathematics education journals, their most prolific authors, countries, institutions, current research themes, potential international collaboration, and future research directions.

It should be noted that there have been studies applying bibliometric analysis to chart the distribution of research in mathematics education. Consider the application of mathematical thinking in Indonesia (Supriyadi, 2022). This study aimed to use the Scopus database to chart the rise of mathematical thinking research publications and map out the breakdown of those works by publication mode, academic home, and peer-reviewed journal in Indonesia.

Using the Scopus database, the purpose of this study is to do additional research into the study will be based of learning mathematics publication from Indonesian authors, with the final goal of actively contributing to the development of mathematics education. This investigation centers on bibliometric investigations of publications on mathematics education that have been published in Scopus-indexed journals and are associated with writers from Indonesia. This research makes use of Scopus as a reference database, and either the R programming language package or R itself is used to handle the data obtained from a search for papers pertaining to mathematical reasoning. Scopus is a search engine. The findings of a bibliometric research are presented in this paper, and the main focus of the investigation is on mathematics education in Indonesia. This piece is not a review article because it does not give either a critical analysis or a synthesis of the existing research in the field. By looking at different studies on the process of learning mathematics, academics are hoping to find answers to a number of issues, some of which are listed below.

RQ1. How is the growth of research publications learning mathematics studies from Indonesian Authors?

RQ2. What are the most frequently published sources of publications learning mathematics studies from Indonesian Authors?

RQ3. What are the most influential sources of publications learning mathematics studies from Indonesian Authors?

RQ4. What are the trends in publications learning mathematics studies from Indonesian Authors?

METHOD

A bibliometric analysis was conducted to analyze the current research literature on mathematics learning in Indonesia. The first step in doing a bibliometric analysis is to generate a thorough list of publications that could be in our sample (Oermann et al., 2008). This is a quantitative descriptive research. Researchers want to investigate the evolution of mathematics learning research outcomes in Indonesia, the distribution pattern of publications based on research affiliations, research themes, and scientific journals in Scopus. Bibliometrix R-tool and BiblioShiny were used in this study for data analysis, reduction, visualization, and mapping, respectively. R-Studio was the version of Bibliometrics used to analyze the whole article mapping (Aria & Cuccurullo, 2017).

We started by searching Scopus. The search string combines compound terms and operators typed simultaneously. TITLE-ABS-KEY("Learning Mathematics") AFFILCOUNTRY("Indonesia") were used to search about learning mathematics studies from Indonesian Authors. Scopus data that has been harvested is

then prepared to be processed in the biblioshiny app.. Scopus lets scholars export data to BibTeX, CSV, Plain Text, and RIS, among others. In this study, data was exported in CSV format for import into biblioshiny (Aria & Cuccurullo, 2017).

For the purposes of this investigation, the open-source bibliometrix R-package software was utilized. This software offers bibliometrics capabilities. In the programming language R, Aria and Cuccurullo developed a package called R. (Aria & Cuccurullo, 2017). It includes mathematical, statistical, and scientific mapping algorithms. Biblioshiny is a web interface application that is included in the most recent version of the bibliometrix R-package (2.0 and beyond), which makes it possible for users who are not proficient in coding to conduct bibliometric analysis. BibTex, CSV, or plain text files containing data from Scopus or Web of Science can be imported into Biblioshiny. The Biblioshiny platform processes the data. Biblioshiny's CSV import was utilized in this research endeavor so that we could import data from Scopus.

RESULTS AND DISCUSSION

According to the information that was acquired, the online database Scopus has seen the publication of 1113 documents concerning the teaching of mathematics learning in Indonesia since the year 2008. As of the 22nd of July in 2022, the investigation was finished and closed. During the search that was carried out, the keyword combination TITLE-ABS-KEY("Learning Mathematics") AFFILCOUNTRY("Indonesia") were utilized. The outcomes of the search are presented in Figure 1.

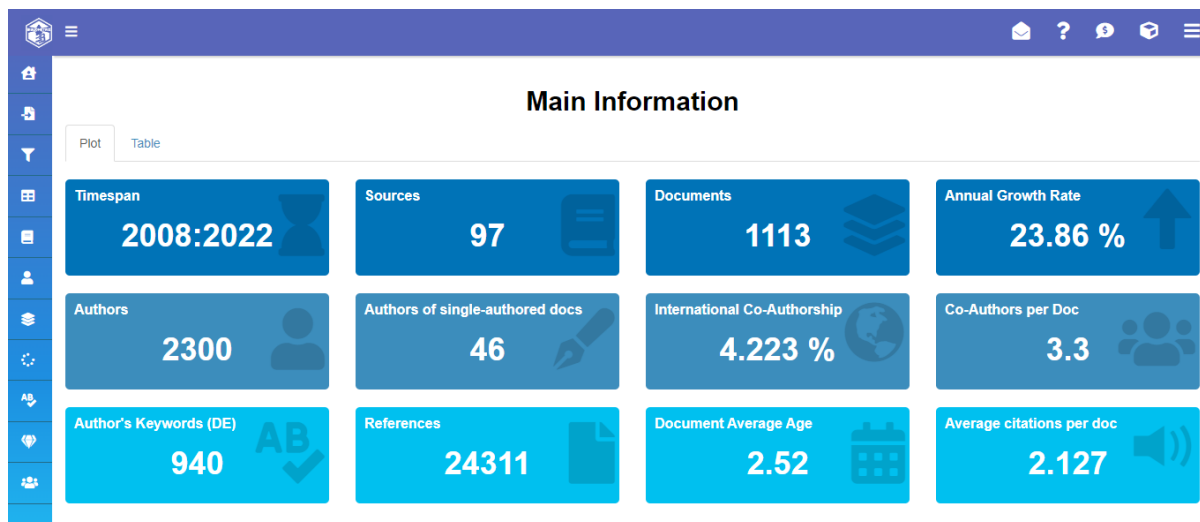


Figure 1. Main information

How is the growth of research publications learning mathematics studies from Indonesian Authors?

There were just four papers published on the subject of learning mathematics in Indonesia during the years of 2008 and 2022. At the beginning of 2008, Scopus contained just a single article, which was an article from (Sembiring et al, 2008). However, that amount increased to 10 articles published in 2016, and it reached its highest point of 357 articles in 2020. It is important to take note that throughout the years 2018–2021, Indonesia published more than one hundred articles in the field of research on mathematics education.

However, in 2021 there were only 237 publications devoted to research on mathematics education, a significant drop from the 357 articles devoted to this topic in 2020. Although there have only been 22 papers on the subject as of July 2022, research on learning mathematics. According to this study's findings on the acquisition of mathematical knowledge, the Annual Growth Rate is 23.86 percent.

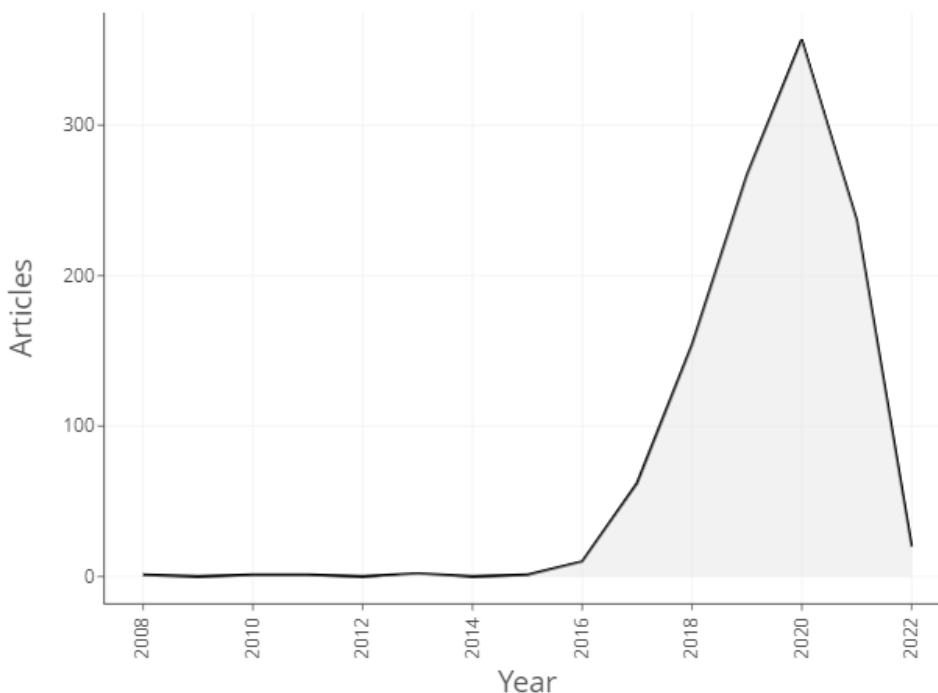


Figure 2. Annual scientific production

What are the most frequently published sources of publications learning mathematics studies from Indonesian Authors?

Between the years 2008 and 2022, Indonesian scholars produced a total of 1113 articles relating to the study of mathematics. Of these, 744 were presented at conferences, while the remaining publications were distributed throughout academic journals. Journal of Physics: The Conference Series has 474 publications, making it the publication with the most mathematics learning research articles in the Scopus online database for the years 2008-2022. Taking into consideration the number of conference publications produced by Indonesian authors in comparison to the number of works that were not presented at a conference. According to the information that was gathered about the publications of research on mathematics education done by authors from Indonesia, the majority of these publications were distributed at international conferences or proceedings, with the AIP Conference Proceedings coming in at number two with 46 different publications. This is a barrier for Indonesian authors who wish to publish their work globally on Scopus without first participating in an international conference.

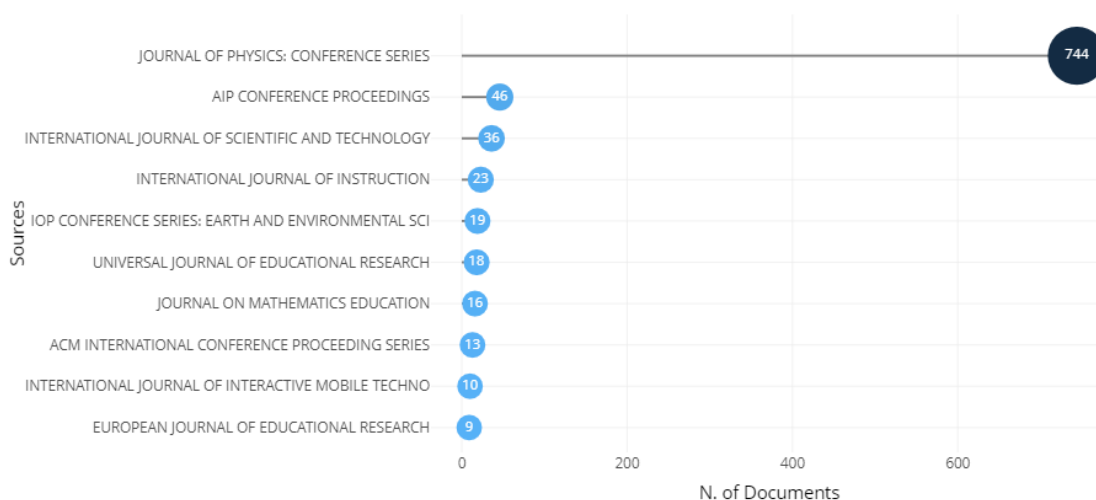


Figure 3. Most relevant sources

By looking at the affiliate IDs listed in the article, one can determine, based on the results of a search in the Scopus database, the distribution of affiliates who carried out research on Mathematics Learning in Indonesia between the years 2008 and 2022. It would appear that the Universitas Pendidikan Indonesia, which has a total of 194 publications and consistently ranks among the top five in search results, is the primary agency

in Indonesia responsible for the implementation of research on mathematics education. Padang State University (with 151 articles), Semarang State University (with 123 publications), Sebelas Maret State University (with 76 publications), and Malang State University (with 55 publications) currently hold the positions that correspond to rankings 2 through 5. According to the information presented in table 4, it is clear that the majority of authors contributing to publications on mathematics learning research in Indonesia are affiliated with state universities that contain a faculty of mathematics education. This is the case because these institutions account for the vast majority of the country's academic output in this field.

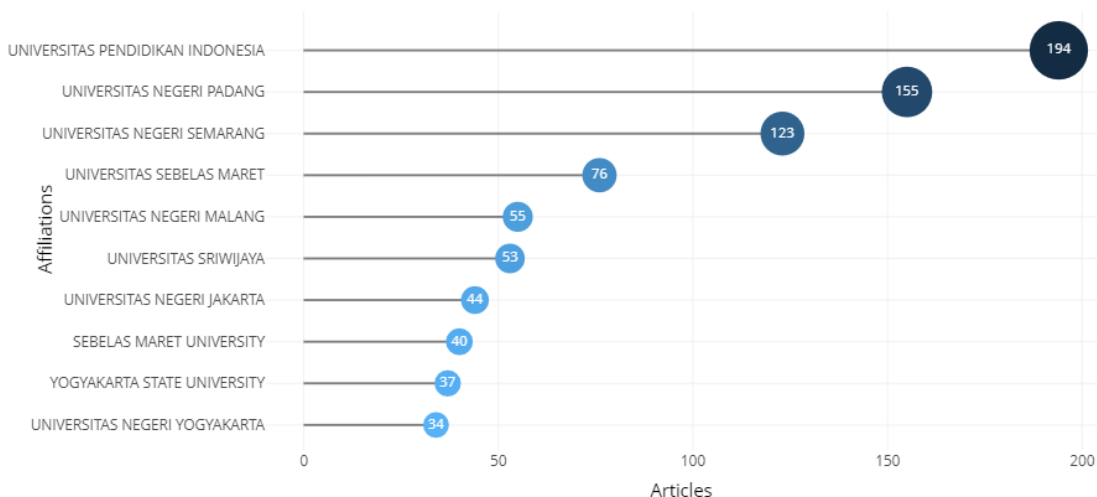


Figure 4. Most relevant affiliations

The following are the findings of local writers who have published the most on research into mathematical education that has been carried out in Indonesia. In addition, we carried out a search with the authors' names as the keywords in order to collect information from the top five authors who were responsible for the production of several publications. Among them are Herman, who has published 23 works; Hobri, who has published 21; Suparman, who has published 20; Juandi, who has published 18; and Arnawa with 17 publications. The following table gives an overview of the articles that were published by the top five writers in the field. The gap between the number of publications on Scopus and the total number of works by the top five local writers who frequently write about research related to the teaching and learning of mathematics is not that wide. Professor Tatang Herman, who teaches mathematics education at Universitas Pendidikan Indonesia and has authored 23 of the studies that are included in this research on mathematical education, is currently in first place. Dr. Hobri, who is both a thinker and a scholar in the field of education in Jember, holds the second position. He is the incumbent of this position.

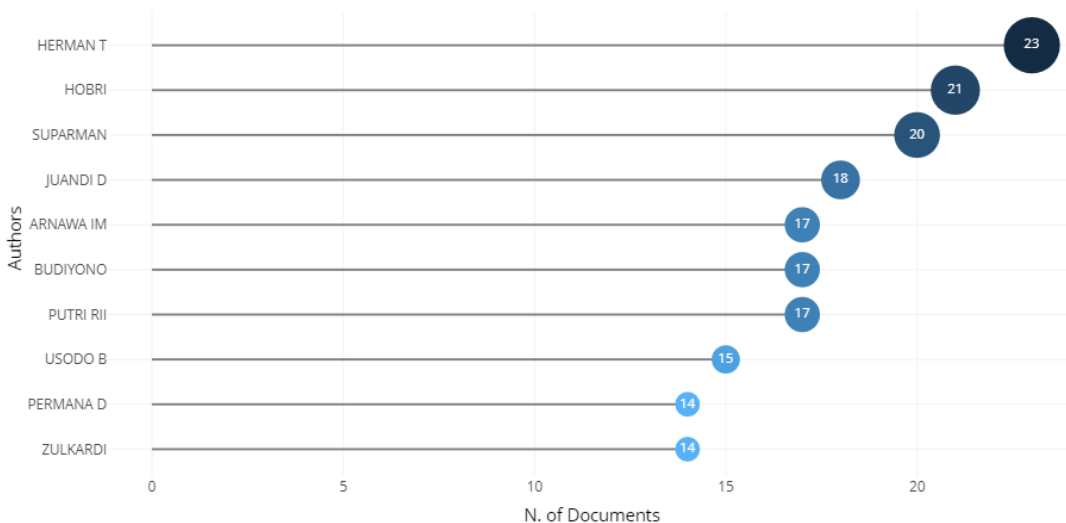


Figure 4. Most relevant authors

What are the most influential sources of publications learning mathematics studies from Indonesian Authors?

In the meantime, the following are the conclusions reached by the authors who have had the biggest impact on the field of mathematics education research published in Indonesia. In addition to this, we do a search using the author's name as the keyword in order to obtain information from the top five writers who are each responsible for authoring several publications. The h-index values of Arnawa and Suparman are both 7, followed by Prahmana (6) and Bernard and Pramudya, who both have an h-index value of 5. Arnawa and Suparman are ranked fifth and third, respectively, when it comes to the most publications of articles on mathematics learning; however, when it comes to the h-index of writings that have an impact on this mathematics learning research, Arnawa and Suparman are ranked first and second, with h-index values of seven and five, respectively. I Made Arnawa is a Professor of Mathematics at the University Andalas, while Suparman holds a Master of Mathematics Education degree from the Universitas Pendidikan Indonesia. The table that follows gives an overview of the top five authors who have influenced studies about the teaching of mathematics in Indonesia.

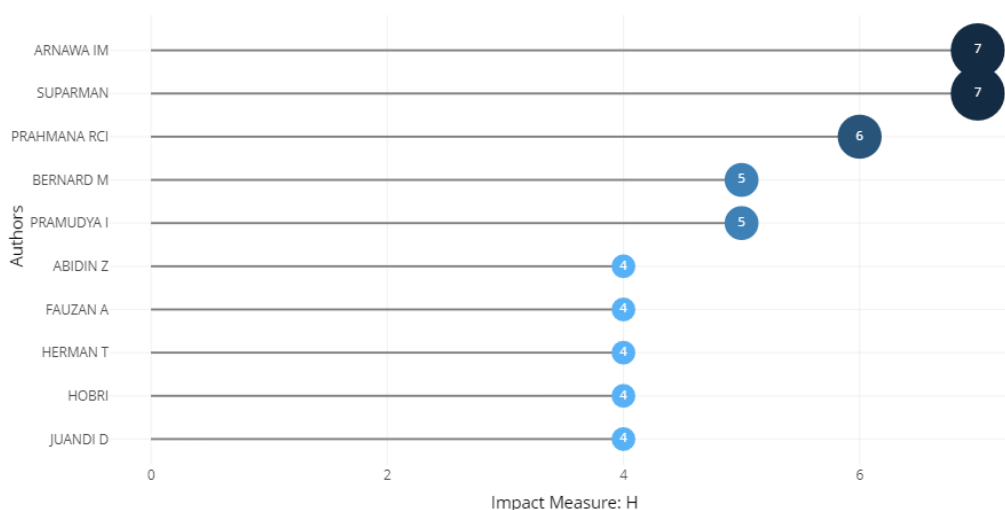


Figure 5. Author local impact

Among the most prominent journal sources in the publishing of research on mathematics learning in Indonesia that was carried out in Indonesia. In addition to this, we do searches based on keywords and publish sites that publish articles or proceedings relating to the subject of studying mathematics. There is the Journal of Physics: Conference Series, which has an h-index value of 13, the International Journal of Instruction, International Journal of Scientific and Technology Research, the Journal on Mathematics Education, which has an indexation value of 7, and the International Journal of Interactive Mobile Technologies, which has an index value of 5. Journal of Physics: Conference Series has the highest value among other sources with an h-index value of 13, and it also has the highest value in terms of the number of publications that have been made in the field of mathematics learning. Many researchers have previously used this publication to publish their findings. Image The following gives an overview of the five research sources that have been shown to have the most significant impact on mathematics education in Indonesia.

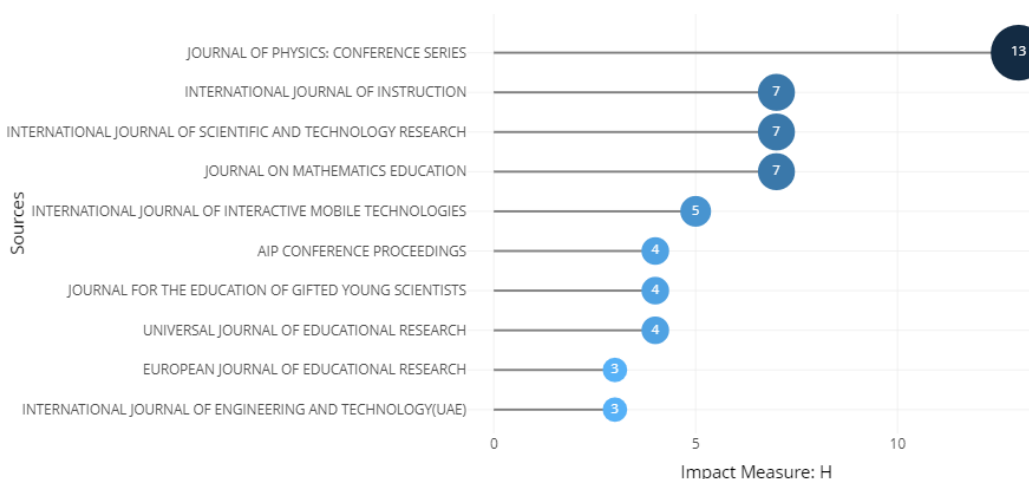


Figure 6. Most local cited sources

Publications that are considered to be among the Most Globally Cited Documents are the result of study that was carried out in Indonesia on the subject of receiving mathematical education. The following authors are among the top three most referenced authors on a global scale: Tanujaya in 2017 came in first, followed by Laurens in 2018 with 70 citations, and Ramadhani in 2019 with 55 citations. Dr. Theresia Laurens, M.Pd. has been appointed to the position of Professor of Mathematics Education at the University of Pattimura's Faculty of Teacher Training and Education. In 2018, he had an article published that was a quasi-experimental research comparing the mathematics cognitive achievement of students who had received RME to those who had had traditional education. During the controlled treatments, students learned mathematics through RME and by playing a board game called "snake and ladder."

In 2017, he did research for Benedict Tanujaya, a professor at the University of Papua. This research took place over the course of three years, from 2014 to 2017. Making use of research methods such as case studies, in-person interviews, and observations. According to the findings of his study, the educational system for learning mathematics in Manokwari is still the same as it is in the vast majority of other regions in Indonesia, and the students' mathematical thinking abilities in the context of mathematics education have not been adequately developed.

In the meantime, Rahmi Ramadhani, an academic from Universitas Potensi Utama, published a study in 2019 that aims to determine the effect of using the LMS-Google Classroom-based Flipped-Problem Based Learning model in the mathematics learning process in high school in the city of Medan, which is located in the province of North Sumatra in Indonesia. This study also investigates the interaction between the students' Prior Mathematics Ability (PMA) levels and the implementation of a flipped-problem based learning paradigm that is based on an online learning management system and Google Classroom.

Table 1. Most global cited documents

Paper	Total Citations	Total Citations per Year
(Laurens et al., 2018)	70	14.00
(Tanujaya et al., 2017)	55	9.17
(Ramadhani et al., 2019)	55	13.75
(Sembiring et al., 2008)	54	3.60
(Saleh et al., 2018)	40	8.00
(Syafriaedi et al., 2019)	32	8.00
(Widada et al., 2018)	29	5.80
(Chotimah et al., 2018)	29	5.80
(Khaeroningtyas et al., 2016)	28	4.00
(Udjaja et al., 2018)	28	5.60

Many authors quote from a variety of sources such as books, theses, and articles published in recognized journals in order to get references from authors or publications that publish about learning mathematics that are not from Indonesian sources. The findings that were collected, which are sources that are frequently used by associated writers in Indonesia outside of articles, are summarized in the following paragraphs. Plomp, Tanujaya and Arnawa are the three references that are mentioned the most frequently from all of these different sources.

In order to provide an introduction to educational design research as appropriate research designs for developing research-based solutions to complex problems in educational practice or for developing or validating theories about learning processes, learning environments, and other topics of this nature, Tjeerd Plomp wrote the book Educational Design Research. This book was published in order to provide an introduction to educational design research.

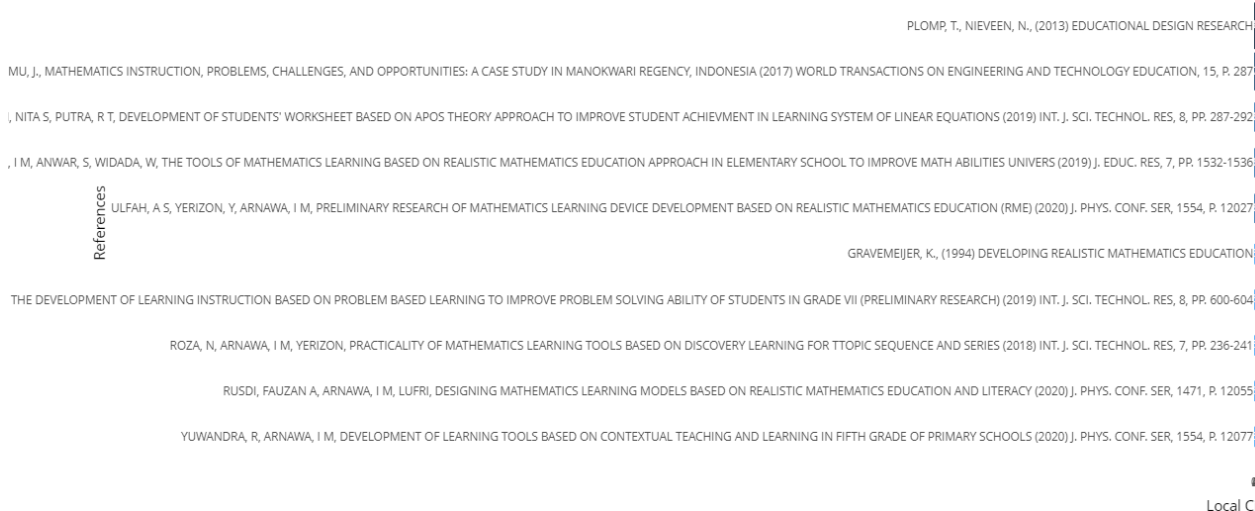


Figure 7. Most local cited references

What are the trends in publications learning mathematics studies from Indonesian Authors?

Based on the analysis conducted by the author's keyword grouping about mathematics learning research in Indonesia, it shows that the trend of research topics in scientific articles on mathematics learning is more towards learning mathematics itself with the emergence of 40 words. Other words that appear are *mathematics* (31), *learning outcomes* (21), *ADDIE* (11), *elementary school* (10), *learning* (10), *problem solving* (10), *design research* (9), *meta-analysis* (9), and *blended learning* (7). This shows that the writers of scientific articles tend to choose the topics of learning mathematics, learning outcomes and Addie. There are topics on addie in mathematics learning research of various topics here. The ADDIE Model is an effective, systematic model that can be adapted for use by instructional coaches to design, implement and evaluate the effectiveness of critical work functions. By encouraging individual or organizationwide use of this model, all stakeholders can be better informed about the impact of the instructional coaching position on teacher capability, and by extension, student results (Danks, 2011).

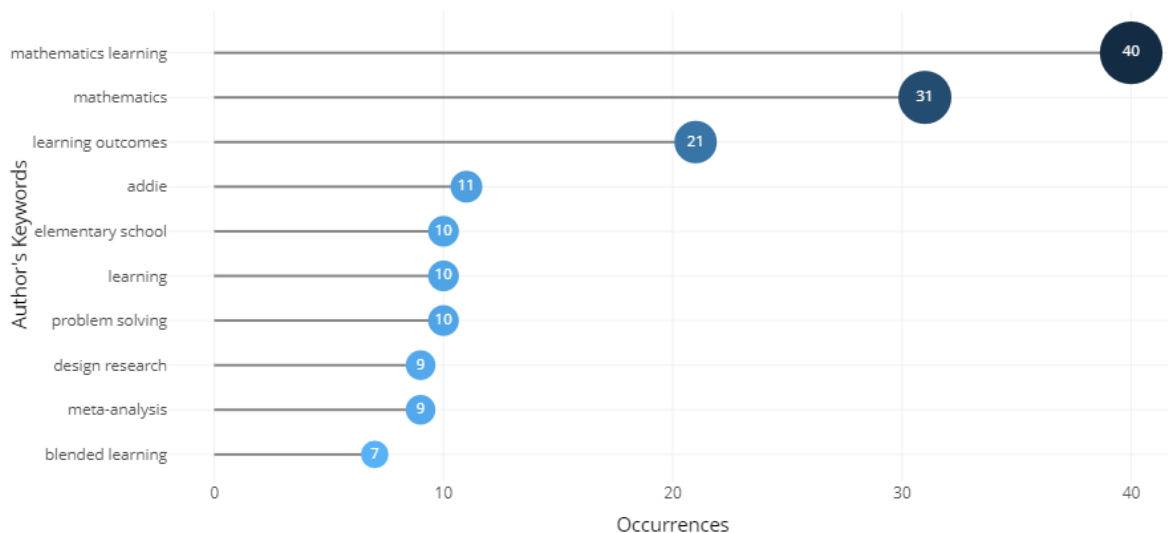


Figure 8. Most frequent words

Research on learning mathematics that has been mostly done by authors from Indonesia in the last two years is by carrying the theme of learning mathematics with the following keywords, "meta-analysis" with 9 publications (Juandi, Kusumah, Tamur, Perbowo, & Wijaya, 2021; Juandi, Kusumah, Tamur, Perbowo, Siagian, et al., 2021), "character education" 5 publications, and "higher-order thinking skills" 5 publications. From this trend, we can see that many Indonesian writers publish on Scopus research that uses meta-analysis research. This is related to the Covid-19 pandemic which has affected the decline in field research, so that the research that is possible to do is meta-analysis research.

Table 2. Trend topics articles in last two years based author's keywords

Authors	DOI
(Juandi, et al., 2021a)	10.3991/ijim.v15i02.18853
(Suparman et al., 2021)	10.1145/3451400.3451408
(Juandi, et al., 2021b)	10.1016/j.heliyon.2021.e06953
(Khadijah et al., 2021)	10.21831/cp.v40i3.39924
(Harun et al., 2021)	10.29333/iji.2021.14413a
(Fuadi et al., 2021)	10.1145/3510309.3510335
(Jaya & Suparman, 2021)	10.1145/3510309.3510316
(Ridwan et al., 2022)	10.17275/per.22.97.9.4
(Setiawan et al., 2022)	10.29333/iji.2022.15249a
(Islam & Suparman, 2019)	-
(Darma et al., 2020)	10.1063/5.0019123
(Lestari et al., 2021)	10.12973/EU-JER.10.1.497
(Prahmana & Istiandaru, 2021)	10.3390/math9222938
(Hidayah et al., 2020)	10.29333/IJI.2021.14132A
(Sumarwati et al., 2020)	10.3991/IJIM.V14I04.12731
(Tanujaya et al., 2021)	10.18421/TEM104-60
(Payadnya & Wibawa, 2021)	10.1088/1742-6596/1957/1/012012

CONCLUSION

This study presents findings that are exploratory in nature from research on mathematics education in Indonesia. This study investigates the central body of scientific work in the subject of mathematics learning with the goal of providing information to educators, lecturers, and institutions of higher education about the current state of research trends in the field of mathematics learning. The data indicate that there has been less study conducted on mathematical education during the past two years. At the present time, the Universitas Pendidikan Indonesia is the association with the most significant influence. When it comes to publications, the Journal of Physics: The Conference Series has more mathematics learning research articles than any other Scopus-indexed journal. The findings of this study need to be analyzed further in conjunction with the findings of other investigations. This study solely uses data from the Scopus database; however, it is also important to perform research using data from other databases, such as the Web of Science, ERIC, and Google Scholar, in order to illustrate developments in a more comprehensive manner.

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