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# MATHEMATICAL LITERACY: A BIBLIOMETRIC MAPPING OF THE RESEARCH LITERATURE IN INDONESIA IN THE LAST DECADE (2014 – 2024)

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## Abstract

*Mathematical literacy is one of the main focuses of Indonesian education. There is much research literature on mathematical literacy, so it is important to conduct a bibliometric mapping analysis. The purpose of this study is to comprehensively describe and visualize research trends on mathematical literacy in mathematics learning in the last decade in Indonesia. The sample of this study was 139 research publications obtained from the Scopus database using the keyword "mathematical literacy", "Numeracy" and "PISA". This research method uses bibliometric analysis assisted by VOSViewer software. The results showed that the highest number of publications of mathematical literacy research in the last ten years was in 2023. Journal on Mathematics Education, Sriwijaya University is the affiliation that publishes the most publication*

*documents related to mathematical literacy. Research topics that have not appeared based on keywords such as error analysis, computational thinking, spatial ability, adversity quotient, self-regulated, and virtual reality related to mathematical literacy which can be used in future research for a broader research area.*

**Keywords**

Mathematical Literacy, Bibliometric Analysis, Research Trend, Scopus, VOSviewer

## 1. Introduction

Mathematical literacy is the knowledge to know and apply the basics of mathematics in everyday life (Ojose, 2011). Furthermore, Ojose described the essential part of mathematical literacy as using, performing and applying mathematical concepts in various situations. According to the Organization for Economic Cooperation and Development (OECD, 2022b), mathematical literacy is a person's ability to formulate, use, and interpret mathematics in various contexts to describe, predict, and explain phenomena by recognizing the role of mathematics in the world. This mathematical literacy ability is a reference for 80 countries that are members of the OECD in the Program for International Student Assessment (PISA) assessment system. The PISA assessment system benchmarks the mathematical literacy skills of students under 15 in each country. The results (OECD, 2022a) show that 55 out of 80 countries, or 68.75% of countries have mathematical literacy skills above the average PISA score. Therefore, students' mathematical literacy skills are a concern for every country at this time.

In the current and future era, one of the mathematical abilities that must be possessed by every individual is mathematical literacy. Mathematical literacy skills have a very important role in solving every contextual life problem that has a relationship with basic mathematical concepts. The results of Pujiastuti & Haryadi's research (2023) showed that students who have good mathematical literacy skills are able to solve mathematical problems. Specifically, every student in school must have skills in mathematical literacy. This is in line with Kusuma et al. (2021), who stated that mathematical literacy skills are fundamental for students to achieve success in the learning process. Proficiency in mathematical literacy is the best way for every student to achieve the learning objectives of mathematics (Kilpatrick, 2001). By having good mathematical competence, students can represent their knowledge in answering contextual mathematics problems (Capone et al., 2021). Thus, students' mathematical literacy skills are very important to continue to be improved and become a concern for teachers, schools, and related governments.

Currently, mathematical literacy skills are one of the main focuses of education in Indonesia. This is because the mathematical literacy skills of students under 15 years old in 2022 only reached a score of 366 which is still far below the OECD average score and this result is not better than the score of students' mathematical literacy results in 2018 (OECD, 2022c). Educational practitioners and researchers have conducted many studies related to students' mathematical literacy skills. Various mathematical literacy studies have been conducted with various multi-disciplines such as mathematical literacy research related to STEM (Susanta et al., 2021); ethnomathematics (Runtu et al., 2023; Umbara et al., 2023); augmented reality (Pujiastuti & Haryadi, 2023); creative thinking (Agustina et al., 2024); Realistic Mathematics Education (RME) based on Adobe flash Pro Cs6 (Umbara & Nuraeni, 2019); and various analyses of mathematical literacy research (Domu et al., 2023; Harisman et al., 2023; Heryani et al., 2023; Murtiyasa & Perwita, 2020).

In the last 10 years, there have been many studies related to mathematical literacy; therefore, it is important to map these studies into a bibliometric study. Zyoud et al. (2022) stated that bibliometrics is a tool for finding research that is being popularly done and often done in a particular field. Arruda et al. (2022) revealed that bibliometrics is an analytical tool that can comprehensively analyse and map the data set formed into a matrix. Donthu et al. (2020) explained that bibliometric studies can analyse and classify existing research results from the research literature into a summary research matrix. Using bibliometric analysis can make it easier for researchers to analyse previously conducted research. Thus, bibliometrics is a tool that can be used to comprehensively analyse and visualise the research literature that has been conducted and create a research summary for further research purposes.

The specific purpose of this study is to comprehensively describe and visualize the trends of mathematical literacy research in mathematics learning in Indonesia in the last decade. The main focus of this research is organized around the following research questions:

1. What is the metric citation and publication research related to mathematical literacy in the last decade in Indonesia?
2. Which document, authors, affiliations, and journals most contributed to mathematical literacy studies in Indonesia?
3. What are the main emerging themes of mathematical literacy studies?

## 2. Methods

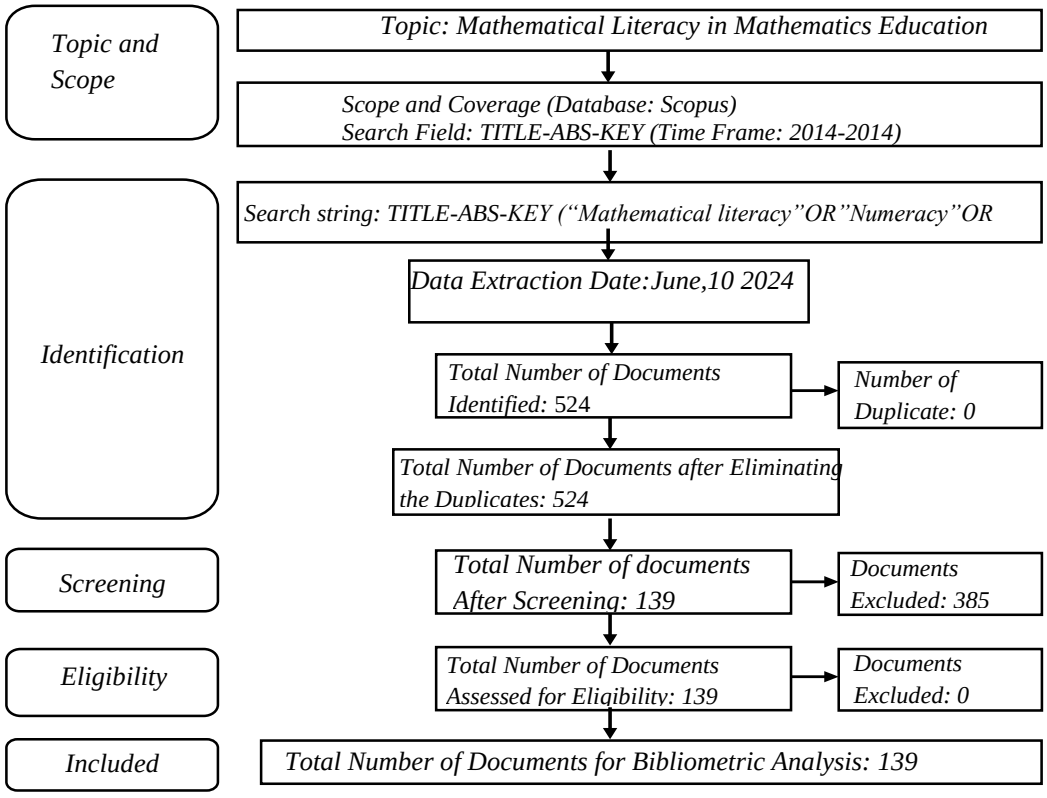
### 2.1. Research Design

The method used is bibliometric analysis to comprehensively describe and visualize the research literature on mathematical literacy in mathematics learning (Arruda et al., 2022). Using bibliometric visualization can make it easier to interpret the research literature in a certain period (Donthu et al., 2020; Garfield, 2009; Szomszor et al., 2020). Research literature collected through the Scopus database. The Scopus database is an internationally indexed database with well-qualified document publications (Zhu & Liu, 2020).

### 2.2. Search Keyword and Extraction Data

The keywords used in the data retrieval process from the Scopus database were specifically "mathematical literacy", "numeracy", and "PISA". The process of collecting data from the Scopus database uses the steps of the literature review system process (Moher et al., 2009) in Figure 1.

**Figure 1**. *Systematic Process Collecting Literature*



Data retrieval was conducted on June 10, 2024, with the keywords "mathematical literacy" OR "numeracy" OR "PISA". Obtained 524 publication documents that do not have duplicate documents that are limited specifically to the range of 2014 - 2024 and only in the country of Indonesia. Then 139 documents after going through the screening process 364 documents were excluded. The excluded process is carried out by considering the subject areas that are included specifically in the "mathematics" and "social science" subject areas according to the scope of this research area. The excluded process also considers the document language which is limited to "English". In the end, 139 eligible documents were obtained according to the criteria and topic of this research. The data was downloaded from the Scopus database in the form of Research Information System (RIS) and Comma Separated Values (CSV) formats for further processing using VOSviewer software (Arruda et al., 2022; Van Eck & Waltman, 2010). RIS format data is uploaded to the Mendeley application to further identify abstracts and titles according to the researcher's wishes.

### 2.3. Data Analysis

RIS format data will be processed using Publish or Perish (PoP) software to show the summary results of publication citation metrics such as average publication year, total citation, cites/paper, cites/author, author/paper, h-index, g-index, and m-index. CSV format data is used to show the distribution of the cumulative number of publication documents each year, as shown in the graphs. This CSV format data will also be processed using VOSviewer software to analyze publication documents and citations, co-author and affiliation, and co-word analysis (Donthu et al., 2020; Fuad et al., 2022; Putra et al., 2023) and to determine research trends, research gaps and research novelty on mathematical literacy in the period 2014 - 2024.

## 3. Result and Discussion

### 3.1 Publication-and-Metrics-Citation

139 documents have been obtained in the data collection process (see table 1) as desired by the researcher. From these 139 documents, the results of publication and citation metrics of research using PoP software are shown in Table 1.

**Table 1:** *Publication and Citation Metrics Related to Mathematical Literacy*

| Description | Results |
|---|---|
| Publication Years | 2014 - 2024 |
| Citation Years | 10 |
| Papers | 139 |
| Citations | 923 |
| Authors | 412 |
| Cites/Year | 92.30 |
| Cites/Paper | 6.64 |
| Cites/Author | 457.98 |
| Author/Paper | 3.14 |
| h-index | 18 |
| g-index | 26 |
| m-index | 0.69 |

Table 1 shows that there are 139 documents that have been published over the past 10 years. Of the 139 documents, 923 citations have been made with an average citation per year of 92.30, meaning that at least 92 or more citations were made per year with an average citation per paper of 6.64, meaning that at least 6 or more citations were made per document, and citations per author of 457.98 with a total of 412 authors during the last 10 years. Based on the above results, this indicates that research on mathematical literacy is in great demand by researchers in Indonesia. It can also be seen that the author's h-index is 18, meaning that there are 18 documents with at least 20 citations, then, the g-index is 26, indicating that there are 26 documents with the highest citations out of 676. Therefore, the m-index value obtained from the ratio between h-index and g-index is 9:13, which is 0.69. The value of m-index ($\alpha$) will always be in the interval $0 < \alpha \leq 1$ this is because the value of h-index is smaller or equal to the g-index according to the results of research by Donthu et al. (2020).

The increase in the publication of research articles on mathematical literacy in 2014 - 2024 can be seen in Figure 2.

**Figure 2:** *Number of Publications Related to Mathematical Literacy (2014 – 2024)*

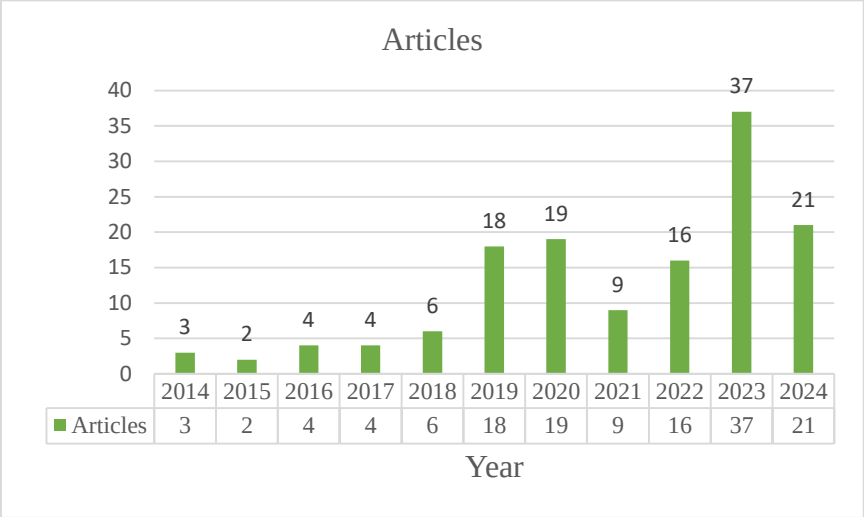



Figure 2 showed the number of mathematical literacy publications in the last 10 years in Indonesia has fluctuated. It can be seen in Figure 2 above that there is a significant increase in the number of publications in the last 6 years (2019-2014), namely 121 publications compared to the number of publications in 2014 - 2018 of only 18 publications. Then, the highest publication of articles related to mathematical literacy in the last 10 years in Indonesia was in 2023, namely 37 documents. In 2024 there were 21 publication documents since data collection was carried out so it needs to be studied further how many total publication documents in 2024 related to mathematical literacy in mathematics learning in Indonesia.

**Figure 3**. *Document types of Mathematical Literacy (2014 – 2024)*

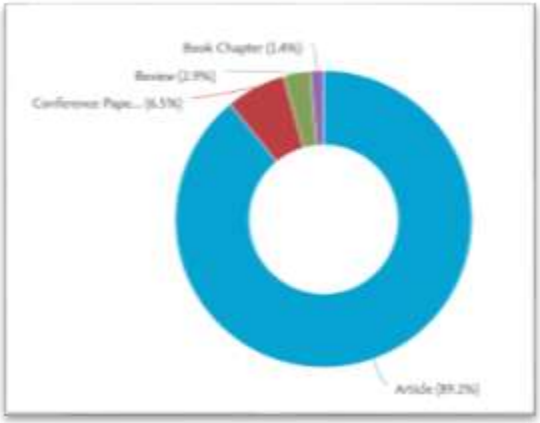


Figure 3 shows that there are 4 types of documents related to mathematical literacy published in the last 10 years, namely articles, conference papers, reviews, and book chapters. It can be seen in Figure 3 that the most published document type is the article type, which is 123 documents (89.1%), then the type of conference paper as many as 9 documents (6.5%), the type of review as many as 4 documents (2.9%), and the type of book chapter as many as 3 documents (1.45%). total all publications are spread in international journals around the world. Furthermore, the specific documents of articles that have been published will be discussed in detail related to the mapping and analysis of publications and their citations.

### 3.2 Science Mapping and Network Analysis

#### 3.2.1 Journal, Affiliation, Author and Citation

123 of the 139 published article documents are spread across 46 international journals around the world mapped in the top 10 journals with the number of documents, citations and journal rank can be seen in Table 2.

**Table 2:** *Top 10 Journal Published Mathematical Literacy (2014 - 2024)*

| No. | Source | Document | Citation | Rank |
|---|---|---|---|---|
| 1 | Journal on Mathematics Education | 27 | 408 | Q2 |
| 2 | Infinity Journal | 14 | 29 | Q2 |
| 3 | Journal of Higher Education Theory and Practice | 9 | 14 | Q4 |
| 4 | European Journal of Educational Research | 7 | 27 | Q2 |
| 5 | New Educational Review | 4 | 4 | Q4 |
| 6 | Jurnal Pendidikan IPA Indonesia | 4 | 17 | Q3 |
| 7 | International Journal of Educational Methodology | 3 | 7 | Q3 |
| 8 | Mathematics Teaching Research Journal | 3 | 15 | Q3 |
| 9 | International Journal of Evaluation and Research in Education | 3 | 6 | Q3 |
| 10 | International Journal of Instruction | 3 | 48 | Disc. 2023 |

Table 2 shows that the journal on mathematics education, sriwijaya university, Indonesia with Q2 index rank is the most published as many as 27 articles of mathematical literacy documents in the last 10 years and has been cited 408 times which is the highest of other journals. Meanwhile, the second place is followed by Infinity journal, IKIP Siliwangi, Indonesia with Q2 index rank which has published 14 document articles and has been cited 29 times. Of the 46 international journals there are several journals that do not have rank index values due to discontinuous status, one of which is the International Journal of Instruction even though it has published 3 documents and has been cited 48 times. Most of the mathematical literacy article documents were published in international journals with a rank index of Q2. In addition, there is 1 article document published in an international journal with the highest rank index Q1 written by Beatty et al. (2021) in the

International Journal of Educational Development entitled "Schooling progress, learning reversal: Indonesia's learning profiles between 2000 and 2014".

The 139 literature documents obtained with 412 authors can also be mapped into the top 10 affiliations that published research on mathematical literacy in the last ten years which can be seen in Table 3.

**Table 3:** *10 Affiliation with the Highest Publication dan Citation (2014 - 2024)*

| No. | Source | Document | Citation |
|---|---|---|---|
| 1 | Universitas Sriwijaya | 22 | 353 |
| 2 | Universitas Negeri Yogyakarta | 15 | 189 |
| 3 | Universitas Negeri Semarang | 14 | 22 |
| 4 | Universitas Negeri Malang | 11 | 56 |
| 5 | Universitas Pendidikan Indonesia | 10 | 46 |
| 6 | Universitas Negeri Surabaya | 8 | 36 |
| 7 | Universitas Muhammadiyah Surakarta | 4 | 43 |
| 8 | Universitas Jember | 4 | 13 |
| 9 | Universitas Padjajaran | 4 | 3 |
| 10 | Universiti Teknologi Malaysia | 4 | 0 |

Table 3 shows that the affiliation that has conducted the most research related to mathematical literacy in the last ten years is Sriwijaya University, which has published 22 documents with the most citations, namely 353 citations. Then followed by Yogyakarta state university which has published 15 documents and has been cited 189 times. The third is Semarang State University, which has published 14 documents and has been cited 22 times. The 4th - 10th order can be seen in table 3 above. Authors from each affiiation have contributed to research related to mathematical literacy in the last 10 years. If we look at Sriwijaya University with the highest number of citations, it indicates that authors from Sriwijaya University will be the most popular in conducting research related to mathematical literacy in the last 10 years. Specifically, to see the authors who have contributed to research related to mathematical literacy in the last 10 years can be seen in Table 4.

**Table 4**. *10 Authors with the Highest Publication and Citation (2014 – 2024)*

| No. | Author | Total Publication | Total Citation | Affiliation |
|---|---|---|---|---|
| 1 | Zulkardi | 16 | 276 | Sriwijaya University |
| 2 | Putri, R I I | 15 | 200 | Sriwijaya University |
| 3 | Sukestiyarno YL | 6 | 19 | Semarang State University |
| 4 | Waluya, SB | 5 | 4 | Semarang State University |
| 5 | Nusantara DS | 4 | 57 | Sriwijaya University |
| 6 | Cahyono AN | 4 | 10 | Semarang State University |
| 7 | Kurniati D | 4 | 13 | Jember University |
| 8 | Retnawati H | 3 | 13 | Yogyakarta State University |

| | | | | |
|---|---|---|---|---|
| 9 | Umbara U | 3 | 42 | STKIP Muhammadiyah Kuningan |
| 10 | Wijaya A | 3 | 147 | Yogyakarta State University |

Table 4 shows that the authors who published the most documents related to mathematical literacy in the last 10 years are Zulkardi and Putri, RII from Sriwijaya University. In the last 10 years, the name "Zulkardi" was recorded in 16 documents that have been cited 276 times and also the name "Putri, RII" was recorded in 15 documents that have been cited 200 times. This is because both names are simultaneously recorded in the same publication document and come from the same university. The same thing also happened to the author: Sukestiyarno YL, Waluya, SB, and Cahyono AN, the three authors' names were recorded in several documents of the same publication. Specifically, the citations per publication document of the authors of mathematical literacy in the last 10 years can be seen in Table 5.

**Table 5**. *10 Articles with the Highest Citation (2014 – 2024)*

| No. | Author (Year) | TC | TC/Y | Journal |
|---|---|---|---|---|
| 1 | (Wijaya et al., 2014) | 112 | 10,2 | Mathematics Enthusiast |
| 2 | (Oktiningrum & Hartono, 2016) | 44 | 4,5 | Journal on Math Education |
| 3 | (Wijaya, 2016) | 35 | 3,9 | Journal on Math Education |
| 4 | (Ahyan, 2014) | 33 | 3 | Journal on Math Education |
| 5 | (Dewantara, 2015) | 32 | 3,2 | Journal on Math Education |
| 6 | (Umbara & Suryadi, 2019) | 30 | 5 | International Journal of Instruction |
| 7 | (Putri, 2020) | 28 | 5,6 | Journal on Math Education |
| 8 | (Nusantara & Putri, 2021) | 27 | 6,75 | Journal on Math Education |
| 9 | (Novita & Putra, 2016) | 27 | 3 | Journal on Math Education |
| 10 | (Efriani & Putri, 2019) | 26 | 4,3 | Journal on Math Education |

TC = Total Citation, TC/Y = Total Citation per Year

Table 5 shows the article written by (Wijaya et al., 2014) entitled "Difficulties in solving context-based PISA mathematics tasks: An analysis of students' errors" is the article with the highest citation which has been cited 112 times with an average citation per year of 10.2. This means that the article is at least 10 times or more cited by other authors. In second place followed by an article written by (Oktiningrum & Hartono, 2016) entitled "Developing PISA-like mathematics tasks with Indonesian natural and cultural heritage as context to assess students' mathematical literacy" which has been cited 44 times. When comparing the number of citations of the most authors between "Zulkardi and Putri" and "Wijaya", the number of citations of articles written by Wijaya is higher

than the article written by Zulkardi which is ranked 13th which has been cited 23 times with an average citation per year is 4.6 while the article written by Putri is ranked 7th which has been cited 28 times with an average citation per year is 5.6.

### 3.2.2 Co-word Network Analysis

Co-word analysis is one of the appropriate methods to identify the distribution of keywords that are widely used in a certain period (Putra et al., 2023). The purpose of co-word analysis is to describe the structure of the keyword conceptual framework, map and group the co-occurrence of keywords from each literature (Aria & Cuccurullo, 2017). Co-word network analysis can be used to identify research clusters based on co-citation patterns and network structural properties of the clusters (Gurzki & Woisetschläger, 2017). In this case, keyword network analysis is to describe and describe the co-occurrence of keywords that appear most in a certain period. The keyword network analysis in this study is the minimum number of 2 co-occurrence keywords in each document from a total of 358 keywords. To identify the co-occurrence network of keywords related to mathematical literacy will be shown through co-word network visualization (figure 4) and to see the most recent keywords related to mathematical literacy will be shown in co-word overlay visualization (figure 5).

**Figure 4**: *Co-Word Network Visualization*

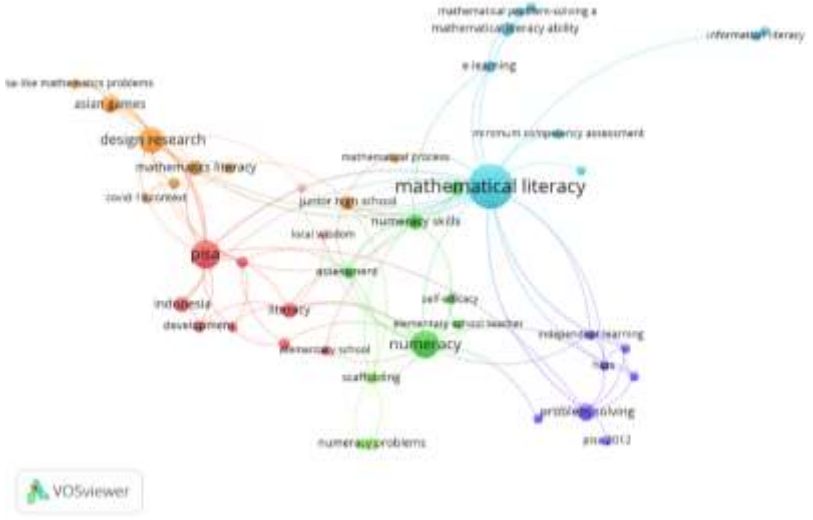



Figure 4 shows the 45 co-occurrence keywords grouped into 4 large clusters, namely orange, red, green, purple, and blue clusters. The orange cluster consists of 9 keywords, the red cluster consists

of 9 keywords, the green cluster consists of 9 keywords, the purple cluster consists of 7 keywords, and the blue cluster consists of 11 keywords. In the orange cluster, the keyword "design research" is the most common keyword. The focus of research in this cluster is research on the development of question preparation related to mathematical literacy with various contexts such as the covid-19 context, the context of the Asian games and mathematical problems such as PISA questions. In the red cluster, the focus of research in this cluster is the preparation of mathematical literacy questions such as PISA questions that are implemented in elementary and junior high school students in the Indonesian region. In the green cluster, the focus of research in this study is the assessment of teacher numeracy skills related to self-efficacy. In the purple cluster, the focus of this research is problem solving on HOTS questions such as the 2012 PISA questions related to independent learning styles. And finally, the focus of research in the blue cluster is the assessment of students' minimum competency in mathematical literacy related to the students' self-efficacy.

Figure 5 shows the most used keywords in mathematical literacy research in the last ten years. The color degradation represents the keywords in a particular period. The light green to yellow color degradation represents the latest mathematical literacy keywords in 2023-2024, and the dark purple color degradation represents the mathematical literacy research keywords in 2018 and below. Co-word overlay visualization analysis using a minimum number of 1 co-occurrence keyword from each document obtained 275 interrelated keyword networks from 358 total keywords.

**Figure 5**. *Co-word Overlay Visualization*

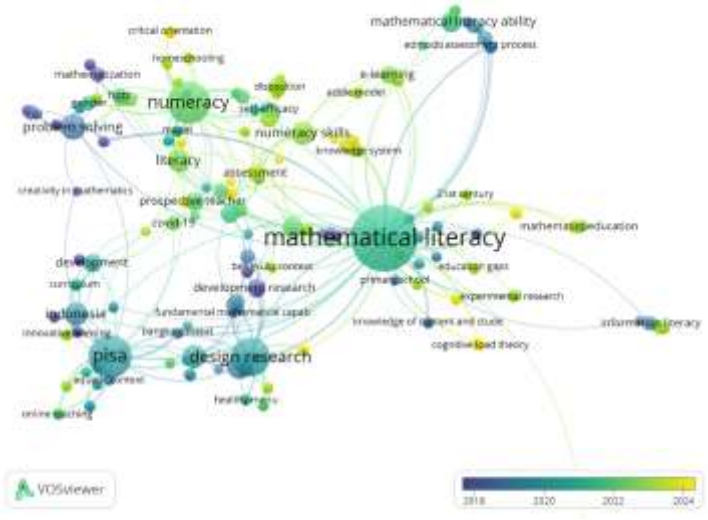


Figure 5 generally shows the keywords used in mathematical literacy research oriented to the assessment of students' mathematical literacy at the elementary school and secondary school levels. The assessment of mathematical literacy is used with various approaches such as ethnomathematics contexts, mathematical contextual problems, and mathematical problem problems that refer to PISA questions. Specifically, the keywords that appeared in learning related to mathematical literacy are guided-inquiry learning, realistic mathematics education (RME), directed instruction learning, design-problem learning, open-ended approach, problem-based learning, project-based learning and digital-game-based learning. Meanwhile, the media keywords that appear in mathematical literacy research are adobe flash professional CS6, microsoft-kaizala, edmodo, game-based multimedia, and virtual mathematics kits (VMK). Meanwhile, the keywords on affective aspects that appear in the figure above are disposition, beliefs, field independent and self-efficacy. Therefore, future research needs to use other affective aspects such as self-regulated, field-dependent, adversity quotient, and/or combine them. Furthermore, the keywords that emerged related to mathematical literacy content were change and relationship and space and shape. Therefore, future research needs to address mathematical literacy content related to quantity and uncertainty and data.

Recent keyword pairs that emerged related to mathematical literacy are critical orientation - numeracy problem; creative thinking - mathematics literacy; ethnomathematics - bibliometric analysis; ethnomathematics - teacher beliefs; design-based learning - cognitive load theory; LEPscO - teacher mobilizer - learning environment; scaffolding - field independent student; assessment - special education teachers; augmented reality - secondary school; and RME - elementary school. Keywords that have not appeared such as computational thinking, spatial ability and others, affective: adversity quotient, self-regulated and field-dependent, and media: virtual reality can be used in future research.

## 4. Conclusion

Mathematical literacy is a popular topic that is widely researched by researchers, educational practitioners, and also the government in providing policies on the curriculum. It can be seen from the productivity of mathematical literacy research publication documents in the last ten years has a positive trend. In the last ten years, Zulkardi and Putri RII were the authors who published the most publications simultaneously related to mathematical literacy. Journal on Math

Education is the journal that publishes the most mathematical literacy research literature. This has an impact on Sriwijaya University as the affiliation that publishes the most documents related to mathematical literacy. However, the article written by Wijaya from Yogyakarta State University is the most cited article by other researchers. Research topics that have not appeared based on keywords such as computational thinking, spatial ability, adversity quotient, self-regulated, and virtual reality can be used in future research for a wider research area.

Based on the findings of the analysis, it can be concluded that mathematical literacy research still has a close relationship between the concepts of assessment, learning and mathematical literacy itself. Technology-assisted innovative learning can be implemented in mathematical literacy learning. The government and educators should always conduct assessments based on PISA standardized assessments so that students are accustomed to solving HOTS questions that have an impact on Indonesia's PISA mathematical literacy results. Mathematical literacy research can still be used in the future which is associated with computational thinking, error analysis, adversity quotient, self-regulated, virtual reality and technology-based learning media.

The limitation of this study is that the data source taken is still only from 1 source, namely the Scopus database. For further research, that is still one theme with this research can take data sources from other databases such as Sinta, Dimension, WoS and others. The publication year limitation is still limited to June 10, 2024, it is necessary to conduct further analytical studies until the end of the year.

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