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Bibliometric Analysis of the Ability to Solve Algebra Problems in Elementary School AKM Numeracy Context

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ABSTRACT

Objective: The purpose of this bibliometric analysis is to look at opportunities and trends in research related to the completion of algebra context numeration Assessment of Minimum Competence at the level of Elementary School using the VOS Viewer application. ***Method:*** The method used in this research is bibliometric, collecting data from articles or journals from 2021 to 2023 through the Google Scholar site using the Publish or Perish software of 500 articles or magazines. ***Results:*** Similar research results show that in 2021, there were 101 publications; in 2022, there were 166; and in 2023, there were 198. The number of quotes was 2097; the average quotation per year was 699; the quotations per paper was 4.51; the averages per writer were 1,222.65; the median number of papers/writers was 293.32; and the average number of writers/publishers was 2.09. ***Novelty:*** Variables related to the completion of algebra issues through the Minimum Competence Assessment at the elementary school level that have the opportunity and novelty to be studied in the future are in the context category of numeration consisting of personal, social, cultural, and scientific.

INTRODUCTION

Mathematics will have an influential function in future lives, but today, mathematics is still the bump of most students. Therefore, it is necessary to provide a form of learning that can please students (Wardhani & Oktiningrum, 2022) to understand and master mathematics concepts correctly (Yanti, 2019). Other efforts that could be made should not only focus on improving cognitive abilities (Kusuma & Nurmawanti, 2023) but also attempt to enhance the emotional component of students. During teaching activities, teachers must have professional knowledge or classroom management skills to teach the subject matter (Nuzulia & Gafur, 2022) because each student has different abilities and levels of reasoning (Sunhaji, 2014). To do this, teachers must have the appropriate learning style and methods to enable students to understand the subject matter taught (Wirawan et al., 2023). Mathematics has been taught since primary school in Indonesia because it has some urgency (Dwi & Fajar, 2022). The advantages of mathematics are to shape the logic of thinking (Nurfadhillah et al., 2021) systematically needed in solving everyday problems (Sohilait, 2021). Therefore, in the preparation of mathematics curricula in Indonesia, the primary goal of learning math is to help students have the ability to solve problems (Sari et al., 2021).

Mathematics is the universal science and the foundation for advancing modern technology, it plays a vital role in various fields of science (Nurgiyanto et al., 2022) and promotes the development of human thought (Budi et al., 2023). Mathematical subjects must be offered to cultivate students' rational, sharp, systematic, critical, and creative assumption skills (Sari et al., 2021) and collaborative skills starting from elementary school. These skills are needed so that students can acquire, organize, and use

information to survive in changing, uncertain, and competitive environments in the future (Wirawan et al., 2023).

At the time, Mathematical education in Indonesia had yet to acquire the capacity expected fully (Prihapsari et al., 2023). The 2015 TIMSS survey data showed that Indonesian students' mathematical ability scored only 397 points, lower than the TIMSS Scale Centerpoint standard of 500, so Indonesia ranked low (Solikhah, 2021). Meanwhile, the 2019 TIMSS Indonesia study results were unavailable because Indonesia needed to take the opportunity. The government's latest research, through the National Assessment, shows that students only had 50.00% good reading skills, while students' ability to answer mathematics correctly reached only 33.00% (Rosa, 2022).

The study's results by Umar (2023) show that algebra solving can be used in various ways, including using the knowledge acquired by the teacher while on the school bench. Furthermore, students need to be equipped and trained to develop their creativity by compiling various answers to a solved question through various methods of solving it according to the student's wishes. However, according to Khairizka et al. (2023), the ability to solve algebra matters reviewed from high school characters has an average of 61.00% (high category). Most students need help with their reasoning and argument skills. This is because students are less able to understand, receive, or digest the material (Nurhayati et al., 2022), and students need help planning strategies in problem-solving (Fauziyah, 2023).

The numbering skills in the Score Minimum Competency (*Re: AKM*) are different from the mathematical skills of the students (Klarita & Syafiah, 2022). This is because the ability of mathematics alone is not enough for the students to master numeration skills (Kusuma & Nurmawanti, 2023). At the same time, numeration requires the application of concepts and knowledge in solving problems (Ismafitri et al., 2022) that require many ways of solving or even mathematical problems that have no solution (Novianti, 2021). Competence Assessment Minimum literacy aspects of numeration are contextual (Lestari & Madiun, 2023), measure problem-solving competencies (Lestari, 2022), and stimulate students to think critically (Patriana et al., 2021). The component of numeration consists of three main parts: content, context, and cognitive processes (Purwati et al., 2021). The components of content in numeration include the material of numbers, algebra, data, geometry, and measurement (Denbel, 2023; Gusmawan & Herman, 2022; Lubis & Permatasari, 2023; Mufidah et al., 2023; Triwahyuningtyas et al., 2023; Zhang et al., 2020).

The context component includes personal, socio-cultural, and scientific, while the cognitive component involves understanding, application, and reasoning (Amalia & Wuryandani, 2020; Dasen, 2022; Fenici & Zawidzki, 2021; Kaidesoja et al., 2022; Romine et al., 2020; Silva et al., 2021; Vasiliev et al., 2021). It further explains that for the numeration context, there is also a personal context that focuses on a person's activity, family, or group. Then, a social-cultural context that relates to the problems of a community or community, whether it is local or regional, national, or global (Ainscow, 2020; Chankseliani et al., 2021; Giglitto et al., 2022; Luo & Lau, 2020; Manca et al., 2021; Schirpke et al., 2020; Sun et al., 2020). The scientific context is related to the applications of mathematics in the universe and issues and topics related to science and technology. Research requires an analysis, one of which is bibliometric analysis. A bibliometric understanding is a study that measures the progress of research (Budi et al., 2023), literature, books, or documents in a particular field either quantitatively or qualitatively

(Hakim, 2020). Bibliometrics is a statistical method that is a proper source of information for publication in the analysis of a particular field (Mihsan, 2023). Then can be concluded that bibliometrics is the library in scientific publications to know the analysis of writing, authors, and literature by statistical methods (Prahani et al., 2022; Prahani, Dawana, et al., 2023; Prahani, Imah, et al., 2023; Saphira et al., 2023).

VOSViewer is a computer program for visualizing bibliometric designs. Text mining capabilities can be used to visualize networks or interrelationships in article quotes (Herawati, 2022). The VOSViewer software will display three visualizations: network visualization, coverage visualization, and density visualization (Rahmawati et al., 2022). VOSviewer is used to find the relationship between theories or themes in scientific literature and supports users in getting trends and forms in specific research fields (Wahyu et al., 2023). VOS Viewer can search databases using Google Scholar, Scopus, Crossref, Semantic Scholar, and PubMed (Subagyo, 2022). Bibliometric studies related to mathematical problem-solving have been carried out, but only limited critical thinking, recommending several variables that can be studied ahead of it, namely flipped classroom variables, high-level thinking abilities, and mathematics anxiety (Herawati, 2022). However, researchers have yet to conduct bibliometric studies on algebra numeration by assessing minimum competence at the primary school level.

The primary research question for this study is: "What are the current research trends in algebra problems within primary school education, specifically in the context of AKM numeration, and how do these trends intersect with personal, socio-cultural, and scientific dimensions?" To break it down further, the study will address how individual factors, such as students' cognitive abilities, learning styles, and personal experiences, influence the teaching and learning of algebra in primary schools. The novelty of this study lies in its comprehensive, multi-dimensional approach to analyzing algebra education trends at the primary school level. By focusing on the AKM enumeration context, the study provides unique insights into the impact of national educational policies in Indonesia. Utilizing VOS Viewer for bibliometric analysis offers a data-driven visualization of research trends, key topics, and influential works, thereby identifying gaps and opportunities for future research. This study paves the way for new research directions, offering a roadmap for advancing algebra education in primary schools.

RESEARCH METHOD

Bibliometric analysis research methods answer research questions by examining research progress and literature. The metadata mapping of the scientific journals used to solve algebra problems in the context of AKM elementary school was taken from reputable and accredited journals in several international journals of Q3 and national journals from Q2-Q6, these journals from 2021 to 2023, and the Google Scholar website contains as many as 500 journals. The various stages of bibliometric analysis are done by compiling articles related to AKM, Algebra, and Arithmetic using Harzing's Publish or Perish software (PoP). The data is then processed and analyzed using Microsoft Excel to obtain tables and graphs. Further, to visualize article data in a web form, I used VOSViewer.

Starting with Harzing's PoP application, enter keywords of numeration, minimum competence assessment, algebra, elementary school, yearly search arrangements 2021-2023, and a maximum of 500 results. The database is selected and used to search for

relevant research articles in Google Scholar for ease of searching and accessibility. The result is shown in Figure 1.

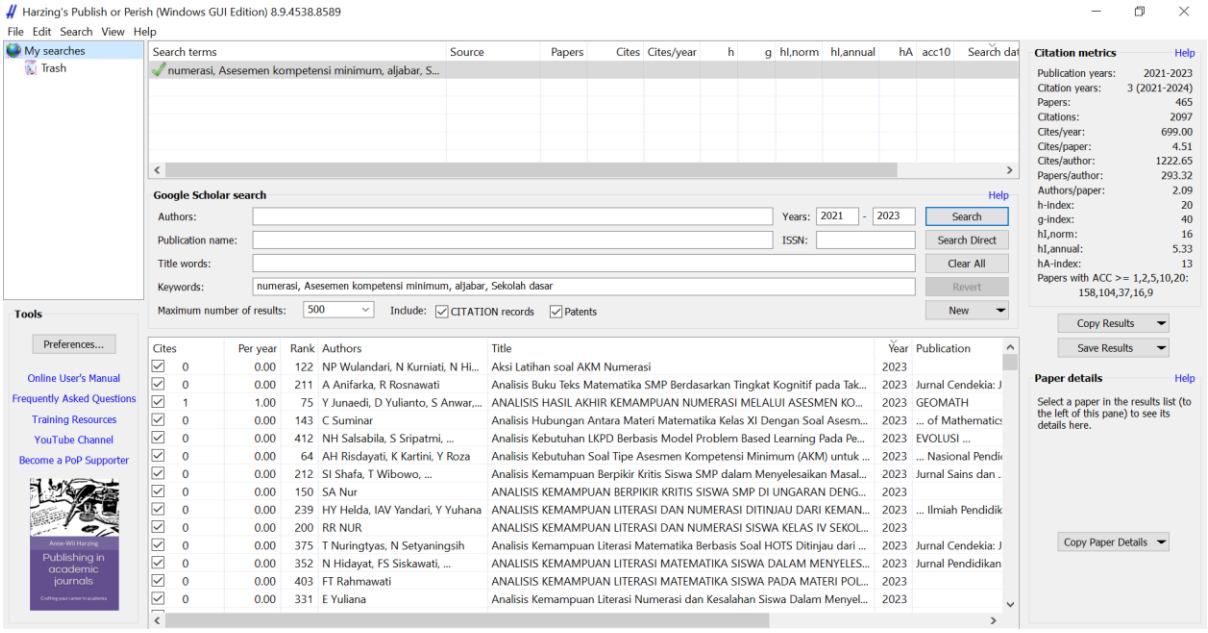

Figure 1. Google Scholar search database.

Based on Figure 1, Google Scholar allows a maximum search volume of 1,000. However, when you picked the level 500, the results showed only 465 journals or articles. The following information is obtained from the Citation marks in Figure 1, which describe the data quantitatively, as shown in Table 1.

Table 1. Citation marks

Results	Description
Keyword	Numeracy, minimum competency assessment, algebra, elementary school
Publication years	2021-2023
Citation years	3 (2021-2023)
Papers	465
Citations	2097
Cites/year	699.00
Cites/paper	4.51
Cites/author	1222.65
Papers/author	293.32
Authors/paper	2.09
h-index	20
g-index	40
hI, norm	16
hI, annual	5.33
hA-index	13

As shown in Figure 1, further data is stored in a variety of required formats such as CSV and RIS, where CSV is used to process tabular and graphic data, and the RIS is used for processing in the form of networks and maps by applying VOS Viewer software. The VOS Viewer software is used to analyze the development diagrams of scientific publications and conclusions on AKM enumeration context algebra in ES.

Data processing output types include network visualizations, overlays, and density visualization (Guo et al., 2021; Huang et al., 2020; Othman et al., 2022; Suprapto et al., 2021; Weiskopf, 2022; Wijewickrema, 2023). Network visualization maps view relationships and group research topics related to keywords. Overlay visualization is used to identify the years in which relevant research themes have been carried out. At the same time, density visualization is used to analyze saturated research topics, but there are still few to no studies. The flow of this research can be seen in Figure 2 as follows (Rahmawati et al., 2022).

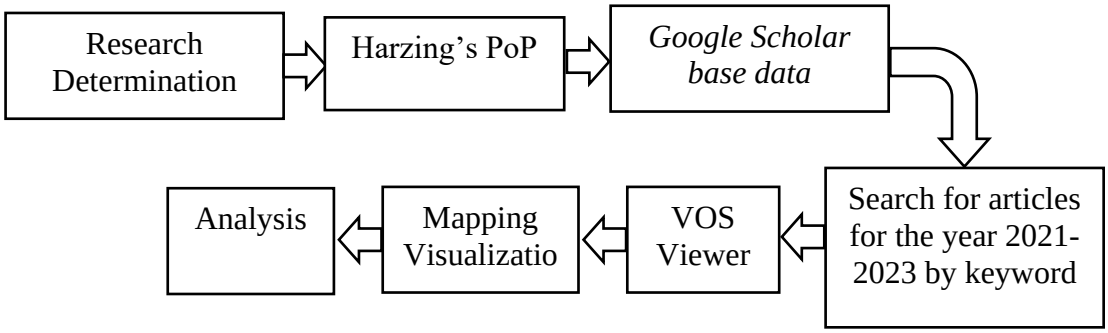

Figure 2. Bibliometric analysis research flow.

RESULTS AND DISCUSSION

Results

Development of scientific publications

Table 2 shows the number of scientific publications made regarding solving algebra questions in the numeracy context of minimum competency assessment at the elementary school level from 2021–2023, with 465 publications published on Google Scholar.

Table 2. Development of scientific publications.

Year	Number of Publications	Percentage (%)
2021	198	42.58
2022	166	35.70
2023	101	21.72
Total	**465**	**100.00**

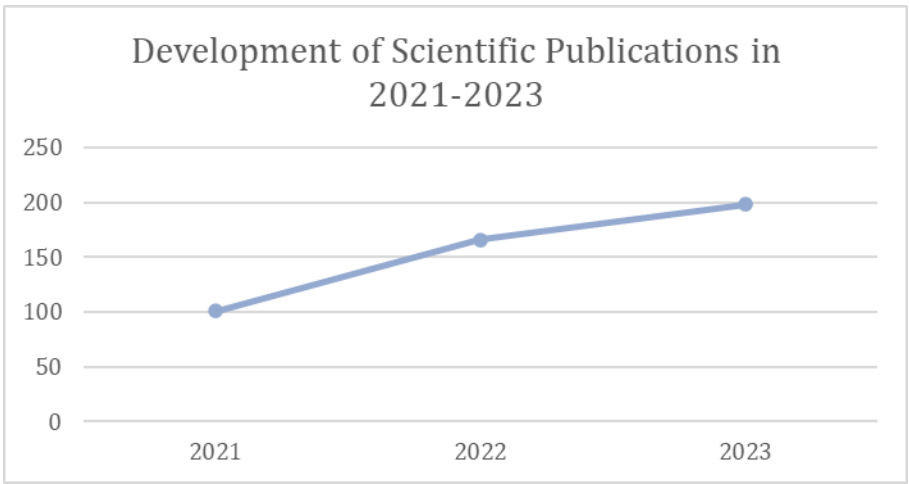

Figure 3. Development of scientific publications from 2021-2023.

Map of scientific publication development

The analysis found 465 articles. Next, they used VOSViewer to view the visualizations. The software allows researchers to continue current research by viewing mapping results that resemble spider webs.

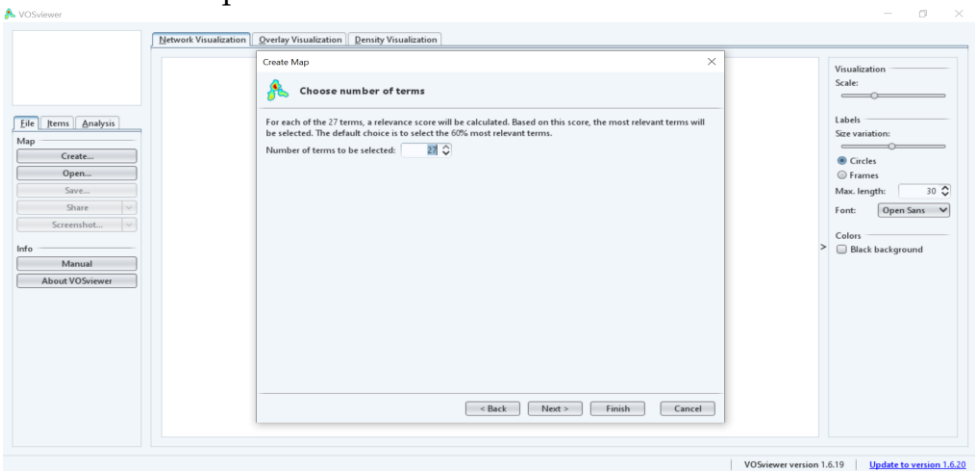

Figure 4. Number of terms in vosviewer.

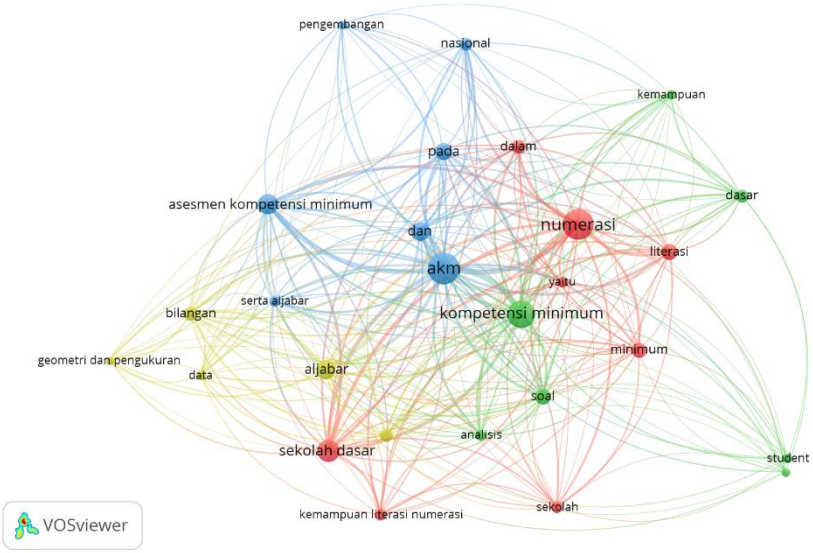

Figure 5. Network visualization of 27 items with 4 clusters.

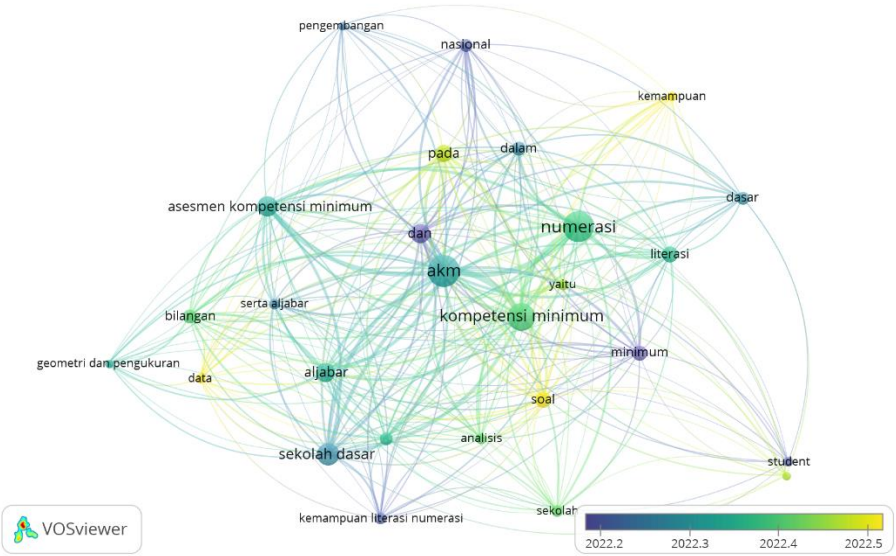

Figure 6. Overlay visualization of 27 items with 4 clusters.

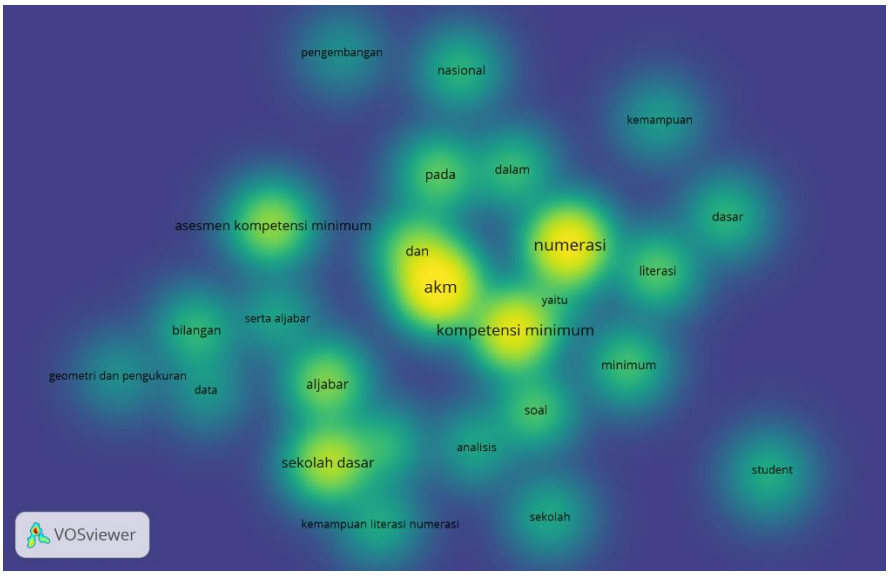

Figure 7. Density visualization of 27 items with 4 clusters.

Discussion

Table 1 shows the bibliometric analysis of articles from 2021 to 2023 based on the Google Scholar database, which reveals significant trends in research on algebra problems in primary schools, especially in the context of AKM numeration. Over this period, 465 articles were published, garnering 2,097 citations. The annual publication rate averaged 699, with an average of 4.51 articles per year and 1,222.65 authors, reflecting a highly collaborative field. The H-index of 20 and G-index of 40 indicate substantial impact and productivity among the published works—the individual H-index of 16 and an annual H-index of 5.33 highlight ongoing, impactful contributions from researchers.

Figure 3 illustrates the rising curve of scientific publications from 2021 to 2023, with a 13.98% increase from 2021 to 2022 (65 additional documents) and a 6.88% increase from 2022 to 2023 (32 additional documents). This continuous growth signifies sustained academic interest and the relevance of the topic.

In Figure 4, the binary method analysis of solving algebra problems in the context of AKM at the elementary school level identifies 2,434 words with a minimum occurrence of 10 times, resulting in 27 significant words. These words are grouped into four clusters:

- **Cluster 1 (Red)**: Focuses on "numeracy literacy skills," "literacy," "numeracy," and "primary school."
- **Cluster 2 (Green)**: Centers on "analysis," "minimum competency," "ability," and "question."
- **Cluster 3 (Blue)**: Includes "AKM," "minimum competency assessment," and "algebra."
- **Cluster 4 (Yellow)**: Contains "algebra," "numbers," "geometry," and related terms.

Identifying thematic clusters within the field of algebra education in primary schools, particularly in the context of AKM numeration, provides significant insights into prevailing research areas and their interconnections. Cluster 1 emphasizes the foundational role of numeracy literacy skills in primary education, highlighting how literacy in numeracy forms the bedrock for students' overall mathematical

understanding. Cluster 2 centers on the methods and implications of assessing students' minimum competencies in algebra, focusing on developing and refining assessment tools to measure students' abilities and identify knowledge gaps accurately. Cluster 3 addresses the intersection of the AKM framework and algebra education, reflecting how national standards and frameworks significantly influence scholarly inquiry. Cluster 4 encompasses research on algebra and related mathematical domains, such as numbers and geometry, suggesting a comprehensive approach to understanding algebra and other vital areas of mathematics. These thematic clusters highlight critical areas for future research and educational practice, such as integrated literacy and numeracy development, refinement of competency assessments, policy-driven research, and a holistic approach to teaching mathematics (Lucas & Venckuté, 2020; Mun et al., 2020; Patterson et al., 2022; Rickey et al., 2023). Understanding these areas can help researchers, educators, and policymakers align their efforts to enhance the quality and effectiveness of algebra education in primary schools (Barrenechea et al., 2023; Burkhardt & Schoenfeld, 2021; Cassata & Allensworth, 2021; Penuel et al., 2020; Stein & Coburn, 2021).

Figure 6's VOS Viewer overlay visualization reveals that minimum competency assessment or AKM variables were widely published throughout 2022 and closely associated with algebra, numbers, geometry, and measurement. The research concentration in 2022-2023 around the AKM variable suggests a central research theme during this period. Figure 7's density visualization indicates that research areas highlighted in lighter colors have ongoing potential for exploration, while darker areas have been extensively studied in 2022. The analysis using VOS Viewer and Harzing's Publish or Perish tools demonstrates that research on the assessment of minimum competence or AKM between 2021 and 2023 has been extensive, focusing on increasing interest, motivation, critical thinking, creative thinking, and topic development. However, a noticeable decline in research related to numeration contexts in 2023 suggests a potential area for further investigation.

The ongoing relevance and evolving trends in the AKM enumeration context highlight opportunities for future research to innovate and address emerging educational challenges. Integrating solutions to problems related to the enumeration of the minimum competence assessment in elementary schools remains a promising avenue (Kwon et al., 2021; Li, 2021; Rich et al., 2020; Roehrig et al., 2021; Wang & Song, 2021). This could involve developing new pedagogical approaches, designing innovative assessment tools, or exploring the socio-cultural impacts on algebra education. The findings emphasize the need for continued research to enhance our understanding and improve educational practices in algebra and numeration within the framework of minimum competence assessments.

CONCLUSION

Fundamental Finding: Based on the findings and results as well as discussions obtained, the number of scientific publications on the site Google Scholar from the year 2021-2023 occurred in the year 2023 as 198 number of publications, while in 2021, it was the lowest number of publications as 101 number of the publications using the software VOS Viewer. **Implication:** Network visualization results found 27 variables with 4 clusters with topics that have relationships, namely Assessment of minimum competence and numeration. **Limitation:** The research results based on overlay visualization and density Visualization by 2022 are focused on the ACM variable, which

means that other researchers have done much research. **Future Research:** Variables related to the completion of algebra issues through the Minimum Competence Assessment at the elementary school level that have the opportunity and novelty to be studied in the future are in the context category of numeration consisting of personal, social, cultural, and scientific.

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