

# INTEGRATION OF THE HISTORY OF MATHEMATICS IN GEOMETRY LEARNING: SYSTEMATIC REVIEW

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## Abstract

This study aims to examine the integration of the history of mathematics in geometry learning with a systematic review. The method used is descriptive analysis by analyzing 7 related journal articles (2015-2024) indexed in Google Scholar. Data analysis was carried out using VOSviewer software version 1.6.18 for graphical bibliometric mapping. The results of the study indicate the importance of integrating the history of mathematics in geometry learning to enrich students' understanding of geometric concepts. Learning models such as the use of historical examples, analysis of ancient manuscripts and exploration of the contributions of previous mathematicians can increase students' awareness and appreciation of the development of mathematics. Therefore, it is recommended for teachers to integrate the history of mathematics in geometry learning to create a more comprehensive and meaningful educational experience.

**Keywords:** *Geometry ; History of Mathetmatic*

## 1. INTRODUCTION

Geometry is an integral branch of mathematics in the formal education curriculum that studies objects related to everyday life. Its learning enriches visual ability, creativity, and prepares students for various careers such as architecture, design, and technology [1]-[3]. The

integration of the history of mathematics into geometry learning is based on two main approaches: (1) a historical approach to understand the development of mathematical concepts, and (2) a geometrical approach that offers concrete visualizations of algebraic concepts that are often abstract. John Fauvel emphasized that the history of mathematics can provide deeper context for students, allowing them to see how mathematical concepts have developed over time and how mathematicians solved complex problems. The integration of history into mathematics learning enables students to understand that mathematics is the result of continuous intellectual development [4]

The integration of the history of mathematics into learning plays an important role in building a deep understanding of mathematical concepts and theories. It enables students to gain a broader perspective on mathematics. Therefore, educators must develop innovative strategies to incorporate historical aspects into the learning process, thereby enhancing the quality of students' understanding (Widyastuti et al., 2024).

In the research on the Integration of the History of Mathematics in Geometry Learning, the bibliometric method is used to analyze publication patterns and main themes through empirical data from related literature. This analysis enables the assessment of literature, identification of trends, conceptual relationships, and recent developments in the field [5]. This method also evaluates author productivity, citation frequency, author networks, and the development of research topics, as well as measures the impact and quality of research dynamics[6].

## 2. RESEARCH METHOD

This study employs a literature review approach by identifying and analyzing key sources relevant to the research topic. The selection of sources is carried out carefully to ensure the accuracy and credibility of the information used.

This study applies a qualitative approach through a literature review method to explore the integration of the history of mathematics in geometry learning. This qualitative approach focuses on an in-depth explanation of the phenomenon of integrating the history of mathematics into the learning process. The literature review method involves collecting relevant information from various sources, including articles, books, and primary reference materials [7]. The method used is descriptive analysis by examining 7 related journal articles (2015-2024) indexed in Google Scholar. The data analysis technique refers to [8], including data collection, data reduction, and interpretation of results. This process uses VOSviewer software version 1.6.18 for graphical bibliometric mapping. The results of the data analysis will be explained in the research findings section.

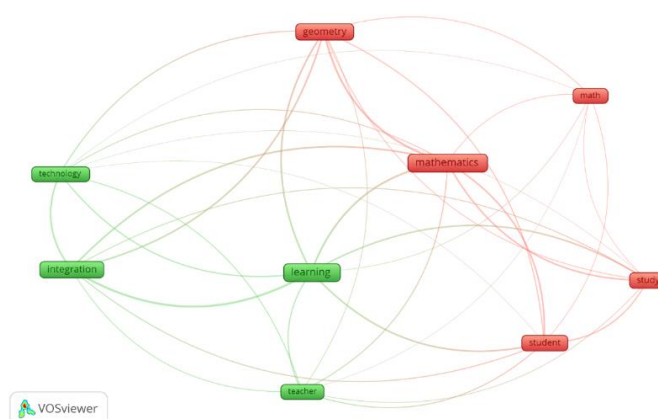
## 3. RESULTS AND DISCUSSION

**Table 1** most popular keywords with the highest ratio of total occurrences and links

| <b>Term</b> | <b>Occurrences</b> | <b>Relevances</b> |
|-------------|--------------------|-------------------|
| Integration | 34                 | 1.23              |
| mathematics | 57                 | 1.14              |
| geometry    | 48                 | 0.89              |
| learning    | 56                 | 0.88              |
| technology  | 15                 | 0.86              |

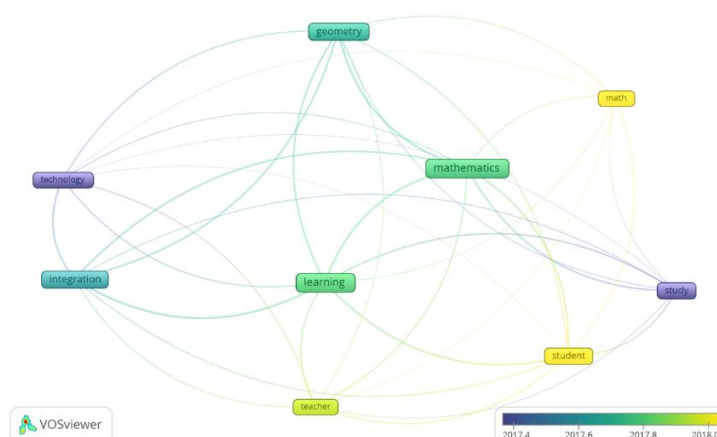
The table above shows the five most popular keywords based on frequency of occurrence and relevance. The keyword “mathematics” has the highest frequency with 57 occurrences and a relevance score of

1.14, followed by “learning” with 56 occurrences and a relevance of 0.88. The keyword “geometry” appears 48 times with a relevance of 0.89, while “integration”, although it appears only 34 times, has the highest relevance score of 1.23. Lastly, “technology” has the lowest frequency (15 times) with a relevance of 0.86. This indicates that keyword relevance is not always directly proportional to its frequency of occurrence. Based on the table above, the data can be presented as follows:



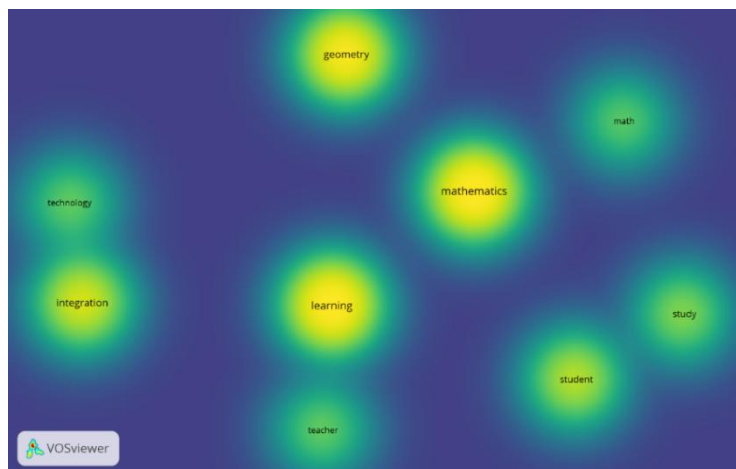
**Figure 1 Cluster of topics on the Integration of the History of Mathematics is Geometry Learning**

Figure 1 is a visualization of the relationships between keywords in mathematics education research using VOSviewer. This visualization shows two main clusters: the red cluster focuses on mathematical concepts and student learning (mathematics, geometry, study, student), and the green cluster reflects the integration of technology in learning (technology, integration, learning, teacher). Both clusters are closely related, indicating an integrative approach in mathematics education.



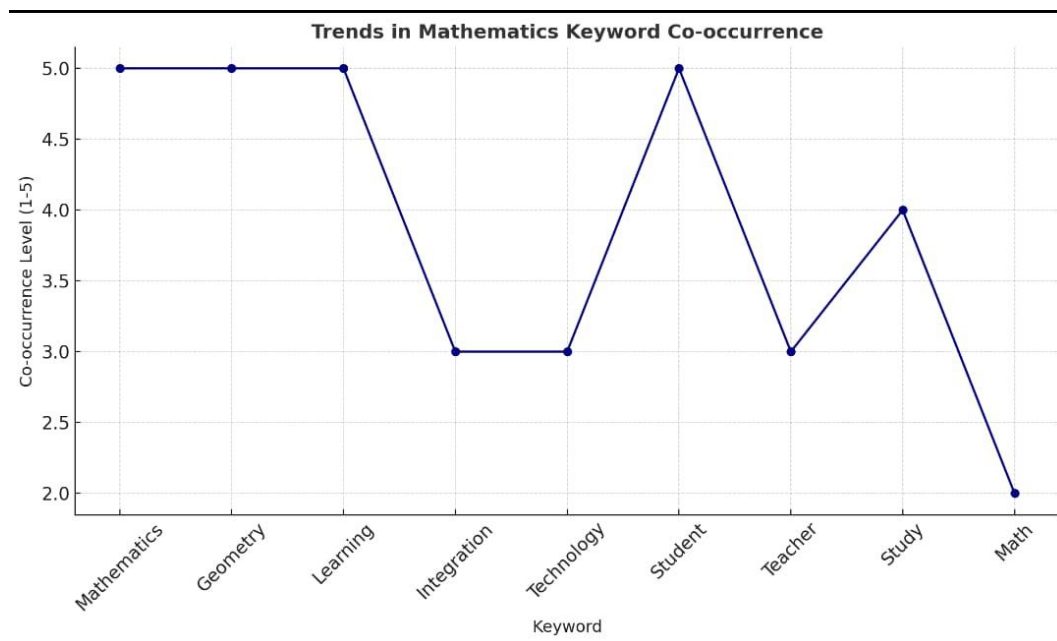
**Figure 2 kluster topik integrasi sejarah matematika dalam pembelajaran geometri**

Figure 2 is a time-based network map generated by VOSviewer, showing the relationships between keywords or topics from the analyzed dataset. The connections or lines between nodes indicate the level of relevance, while the colors represent the time distribution (based on a blue to yellow color scale). The largest nodes such as "mathematics," "learning," and "geometry" indicate high frequency of occurrence. Yellow color indicates more recent research or attention on keywords such as "student" and "study," while blue color shows earlier keywords such as "technology." The complex relationships between nodes illustrate the knowledge structure and integration between topics in this research data.



**Figure 3 Density Mode**

Figure 3 is a data-based density map from VOSviewer, which shows the distribution of topics or related keywords in a research or bibliometric analysis. Each illuminated area shows a group of frequently used keywords, with light intensity representing the level of occurrence or connectivity. The most prominent keywords are "mathematics," "learning," and "geometry," which are located at the center of their respective areas. Other keywords such as "technology," "integration," "teacher," "student," and "study" are spread across various locations, with lower connectivity and density compared to the main center. This pattern illustrates the core topics that are closely related in the research, with a focus on the field of education and mathematics. Based on the publication timeline from 2015 to 2024, there is 1 research publication on the integration of the history of mathematics in geometry learning in 2015, 1 publication in 2018, 1 publication in 2021, 1 publication in 2023, and 3 publications in 2024. Meanwhile, Figure 5 shows the research trend of the integration of the history of mathematics in geometry learning.



**Figure 5 Trends In Mathematics Keyword**

The data in the table show that the keywords "Mathematics", "Geometry", "Learning", and "Student" have the highest level of association (level 5), meaning these words most frequently appear together in the context of mathematics learning. The keyword "Study" has a high association but slightly lower (level 4). Meanwhile, "Integration", "Technology", and "Teacher" are at a moderate level (3), indicating that their association is quite relevant but not dominant. The keyword "Math" has the lowest association (level 2), indicating that this term is less frequently used compared to the word "Mathematics" in the same context.

**Table 2 Journal Article Analysis**

| Researchers                           | Years | Article Title  |
|---------------------------------------|-------|--|
| Dio Renaldi                           | 2021  | Pendekatan Geometri dalam Konsep Penyelesaian Persamaan Kuadrat dengan Melibatkan Sejarah Matematika |
| Eri Widiastuti, Firlin Wardahalia dkk | 2024  | Mengintegrasikan Sejarah Matematika dan Pendekatan   |

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|--|--------------|------|---|
| Achmad Fachrudin                         | Dhany        | 2015 | Pendekatan Geometri Untuk Membangun Konsep Penyelesaian Persamaan Kuadrat Berdasarkan perspektif Sejarah                  |
| Eri Widyastuuti, Orlando Gulton dkk      |              | 2024 | Mengintegrasikan Sejarah Matematika dalam Pembelajaran: Pendekatan Inovatif Untuk Meningkatkan Pemahaman Konsep           |
| Achmad Fachrudin, Intan Kusumawati       | Dhany Bigita | 2018 | Pendekatan Geometris yang Melibatkan Sejarah Matematika dalam Pembelajaran Penyelesaian Persamaan Kuadrat                 |
| Rizky Romadhonah, dan Yunis Sulistyorini |              | 2023 | Studi Etnomatematika Geometri pada Artefak Peninggalan sejarah di Kota Malang   |
| Eri Widyastuti, Alfina Trijayanti, dkk   |              | 2024 | Meningkatkan Pemahaman Sejarah Matematika dengan Mengeksplorasi Ethnomatematics Terhadap Bangunan Bersejarah di Indonesia |

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1. [9], This study discusses the application of geometric methods and the history of mathematics, especially through the Naïve Geometry method from the Babylonian era, to help students understand quadratic equations. This method combines a geometric approach with algebraic representations to solve mathematical problems. The results of the study show that students find it easier to understand abstract algebraic concepts when presented in geometric form. However, it was found that students with low mathematical ability require more assistance in understanding this concept. The researcher recommends further development in other topics to increase student engagement in mathematics learning.

2. [10] This study explores the integration of geometric approaches and the history of mathematics in understanding quadratic equations. The results show that the combination of these approaches is effective in improving student understanding, especially through more concrete geometric visualizations. By transforming geometric representations into algebraic expressions and vice versa, students can understand concepts such as factorization and completing the square. The integration of history provides an engaging context that enhances

student motivation, although further guidance is still needed for students with low mathematical ability.

3. [11], The main focus of the study is the naïve geometry method, which emphasizes the manipulation of geometric shapes to understand quadratic equations more intuitively. The researcher highlights that context-based learning such as Realistic Mathematics Education (RME) can make mathematical concepts more relevant and easier for students to understand. This method connects history and geometric context in algebra teaching. Learning activities are designed so that students can gradually find solutions to quadratic equations, from geometric understanding to algebraic form. This study also emphasizes the importance of the role of the history of mathematics in enhancing students' understanding, enthusiasm, and skills.

4. [12] This article discusses the integration of the history of mathematics in learning as an innovative approach to enhance students' conceptual understanding. By connecting mathematical concepts with their historical development, students can better understand the relevance of mathematics in real life. This approach increases students' motivation, engagement, and problem-solving skills. This literature-based study examines the positive impact of the historical approach in learning, including the introduction of the history of figures, methods, and the development of mathematical concepts to create an active and interactive learning environment.

5. [4] This study was conducted at SMPN 1 Krian, using a design research method that involved three main stages: preliminary design, teaching experiment, and retrospective analysis. The main material taught was an ancient Babylonian geometry method called naïve geometry, which aimed to help students understand the concept of quadratic equations through simple geometric manipulation. The results showed that this approach was effective for students with high mathematical ability, but less optimal for those with lower ability. The

authors also recommended applying this method to other mathematical topics to create more meaningful and engaging learning.

6. (Rizky Romadhonah, and Yunis Sulistyorini), This journal discusses an ethnomathematics study on the artifacts of Singosari Temple in Malang to identify geometric concepts contained in the temple's architecture. This qualitative research used an ethnographic method with observation, interviews, and documentation for data validation. The results showed the application of geometric concepts such as plane shapes (square, trapezoid, triangle, circle) and solid shapes (rectangular prism, cube, pyramid), as well as angle concepts (right, acute, obtuse). In addition, transformational geometry such as reflection and translation was also found in the reliefs and structure of the temple. This study emphasizes the importance of culture-based mathematics learning to improve students' contextual understanding of mathematics.

7. [12], [13], This study discusses the role of ethnomathematics in geometry learning through the exploration of the historical building Maimun Palace in Medan. Ethnomathematics connects mathematics with culture, utilizing architecture to bridge formal mathematical concepts with students' realities. This study used an ethnographic approach to analyze the relationship between culture and geometric concepts such as squares, triangles, and circles in Maimun Palace. The results showed that Maimun Palace has historical and mathematical value that can enhance students' understanding of mathematical concepts and their history.

This study examines previous research focusing on the integration of the history of mathematics and geometric approaches in understanding quadratic equations. This study refers to six articles published in national journals between 2017 and 2021. The integration of the history of mathematics with a geometric approach has been proven to improve students' conceptual understanding and overcome learning obstacles. In addition, this approach also strengthens

students' ability to think analytically and deductively. Students are able to visualize problems, recognize various geometric shapes, and apply geometric principles in algebraic contexts. However, some students require further guidance in translating geometric visualizations into formal algebraic steps.

The results of the study show that the geometric approach makes it easier for students to solve algebraic problems by providing concrete visualization. The naïve geometry method is applied in teaching quadratic equations through manipulation and visualization of geometric shapes. This method offers an intuitive approach, enabling students to better understand the connection between geometric and algebraic concepts. History-based learning also increases students' motivation and interest in learning. Conceptual obstacles, such as difficulties in understanding the form of quadratic equations, are reduced after students are given visual-based learning experiences. This learning design is effective in overcoming epistemological barriers and can be adopted in higher-level mathematics instruction.

According to [14], the history of mathematics is a series of events related to the development of mathematical knowledge. By studying the history of mathematics, students can understand mathematical concepts along with the reasoning behind them. [15] state that the history of mathematics provides a broader context for the concepts being taught, allowing students to see mathematics as a product of human thought that continues to evolve, rather than merely a collection of abstract formulas. The history of mathematics also shows that mathematical discoveries, such as zero or geometry, emerged from real social, cultural, and political needs.

In this study, the naïve geometry method from ancient Babylon is used to help students understand quadratic equations. This approach is carried out through a series of learning activities designed to develop the concept of solving quadratic equations through geometric interpretation. These activities involve solving algebraic problems

using geometric manipulation, such as completing the square and factoring quadratic equations. The main objective is for students to understand the meaning of algebraic symbols through geometric manipulation, build mathematical models, and discover the connection between geometric manipulation and algebraic symbols.

This approach emphasizes the understanding of basic concepts of quadratic equations through visualization and geometric manipulation. The discovery of formulas is not the main focus, but rather students' understanding of the meaning of algebraic symbols and the process of solving quadratic equations through geometric methods. Overall, this learning provides a contextual and meaningful learning experience that not only helps students solve algebraic problems but also enhances their appreciation of the history and development of mathematics.

#### **4. CONCLUSION AND RECOMMENDATIONS**

The conclusion is that the application of history and geometric approaches in mathematics learning has proven effective in improving students' conceptual understanding. This approach helps students build connections between geometric and algebraic concepts, as well as enhance analytical and deductive abilities. The integration of the history of mathematics also makes learning more enjoyable and engaging. Although there are limitations, this approach has the potential to improve the quality of mathematics learning. Therefore, efforts should be made to integrate history and geometry into the mathematics learning curriculum.

It is necessary to develop integrative and interactive learning materials as well as provide teacher training in applying geometric and historical approaches to mathematics. Periodic evaluation is also needed to monitor learning progress and optimize the implementation of this approach. In addition, the use of technology can be optimized

to increase the effectiveness of learning. This analysis emphasizes the importance of integrating theory and practice to improve the quality of mathematics learning.

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