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Exploring Ethnomathematics in Junior High Schools: Indonesia's Contribution and Research Clusters in Enhancing 21st Century Skills

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ABSTRACT

Ethnomathematics is a field that integrates mathematical concepts with cultural elements. At the junior secondary school level, it offers significant benefits by contextualizing mathematics through students' cultural backgrounds and traditions. This study explores the application of ethnomathematics in junior high schools, focusing on Indonesia's contribution to this field and identifying key research clusters. A bibliometric analysis design was employed using data sourced from Dimensions AI. A total of 645 publications were analyzed using VOSviewer and Microsoft Excel. The analysis followed a descriptive qualitative approach to identify trends and patterns in the literature. Findings reveal that Indonesia is the leading contributor to ethnomathematics research at the junior secondary level, indicating its dominant role in this domain. Nineteen research clusters were identified, with primary themes including technology integration, ethnomathematics, batik, mathematical communication, assessment, mathematical concepts, and learning media. These clusters highlight a growing focus on technology-based learning media aimed at enhancing 21st-century skills. The results demonstrate that ethnomathematics in Indonesia is not only culturally relevant but also increasingly aligned with digital innovations in education. The integration of local culture with technology-based media fosters critical skills such as computational thinking and problem-solving. This study concludes that Indonesia plays a significant role in advancing ethnomathematics at the junior high school level, particularly through the development of technology-enhanced learning media that support 21st-century skill development.

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1. INTRODUCTION

Ethnomathematics is a field of study that integrates two disciplines, namely ethnography (cultural studies) and mathematics (Khasanah et al., 2022) . In a broader sense, ethnomathematics includes the study of various mathematical concepts, techniques, and practices that are embodied in the culture and traditions of society. This study not only explores the application of mathematics in specific cultural contexts but also uncovers how cultures shape the perception, use, and development of mathematics (Apriliyani et al., 2023). Ethnomathematics broadens the view of what is considered "mathematics" and recognizes the diversity of approaches and understandings of mathematical concepts across different cultures (R. D. Agustin et al., 2018; Zaenuri, 2020). Thus, ethnomathematics has become an important means of connecting mathematics with daily life, making it more relevant and meaningful for students.

At the junior high school level, ethnomathematics has an important role in introducing mathematical concepts that are relevant to students' cultures and traditions (Rahayu et al., 2023; Romandoni et al., 2024). Through the integration of ethnomathematics in the curriculum, students can understand how mathematical concepts are reflected in their daily lives, both through traditions and local activities. This approach not only provides a more contextual understanding but also increases students' sense of pride in their cultural heritage. In addition, ethnomathematics-based learning helps students relate mathematical concepts to their reality, thereby increasing their interest and motivation in learning mathematics. In this way, ethnomathematics supports learning that is more inclusive and relevant to the needs of students in the era of globalization.

The method of integrating ethnomathematics in the curriculum involves the use of a variety of creative approaches that are relevant to the local culture. One example is the introduction of traditional counting systems used by local communities, such as the number system in certain cultures. In addition, teachers can integrate geometry through the study of local architecture or utilize traditional games involving mathematical concepts as teaching materials (F. D. Agustin et al., 2021; Maharani et al., 2024). Other learning media that can be used are folklore, traditional songs, or local economic practices to teach mathematical concepts in a more interesting way. Collaboration between teachers and students can also be carried out to conduct ethnomathematics research in the surrounding environment, resulting in new insights and contextual learning materials.

Previous research has shown the positive impact of ethnomathematics in mathematics education. For example, the Ethnomathematics-Based Problem-Based Learning (PBL) based learning model is effective in improving students' mathematical numeracy literacy skills (Lestari et al., 2023). In addition, other research highlights the contribution of ethnomathematics in improving students' computational thinking skills, especially in identifying, interpreting symbols, and solving mathematical problems (Muhammad & Marchy, 2023; Romandoni, 2024). However, despite the many benefits identified, there are still research gaps, especially in the exploration of technology-based learning media integrated with ethnomathematics at the secondary school level (Hartanti et al., 2020). Further research is also needed to understand how ethnomathematics can improve student learning outcomes more consistently across different cultural contexts.

This study aims to analyze the application of ethnomathematics at the junior high school level through a bibliometric approach. This analysis involves identifying research trends, key clusters, and the contribution of countries and institutions in ethnomathematics research. The results of this study are expected to provide empirical insights into the benefits of ethnomathematics in mathematics education, especially in supporting the development of a more relevant and contextual curriculum. In addition, this research also aims to open opportunities for the development of technology-based learning media to improve 21st century skills, such as computational thinking. Thus, this research makes an important contribution in bridging the culture, tradition, and learning of mathematics in the modern era.

2. METHODS

This study used a bibliometric analysis design using the Dimension AI database as the primary data source. Bibliometric analysis is a research method used to quantitatively measure and analyze various aspects of scientific publications (Muhammad & Triansyah, 2023). Dimension AI is a database that provides access to thousands of scientific journals, articles, and proceedings in various fields of knowledge (Shamkuwar, 2023). The data collection technique begins with data identification by entering the keywords "ethnomathematics" and "Junior High School" on Dimension AI. The initial search yielded 943 records. Subsequently, data screening was performed to limit the scope of publications from the last 10 years, specifically from the period 2015–2024, resulting in 789 records. The focus on the last decade ensures that the research reflects the most recent developments, trends, and contributions in the field of ethnomathematics, considering the rapid evolution of educational methodologies and technology in recent years. By analyzing data within this timeframe, the study aligns with current global educational standards and practices, ensuring relevance and applicability of findings.

The next step was a due diligence (eligibility) process, with the inclusion criteria limited to articles and proceedings. After applying these standards, the dataset was reduced to 645 records. Finally, the data that passed these selection stages—spanning the last 10 years (2015–2024) and consisting of articles and proceedings—was deemed ready for analysis. For an overview of the data collection process, see Figure 1.

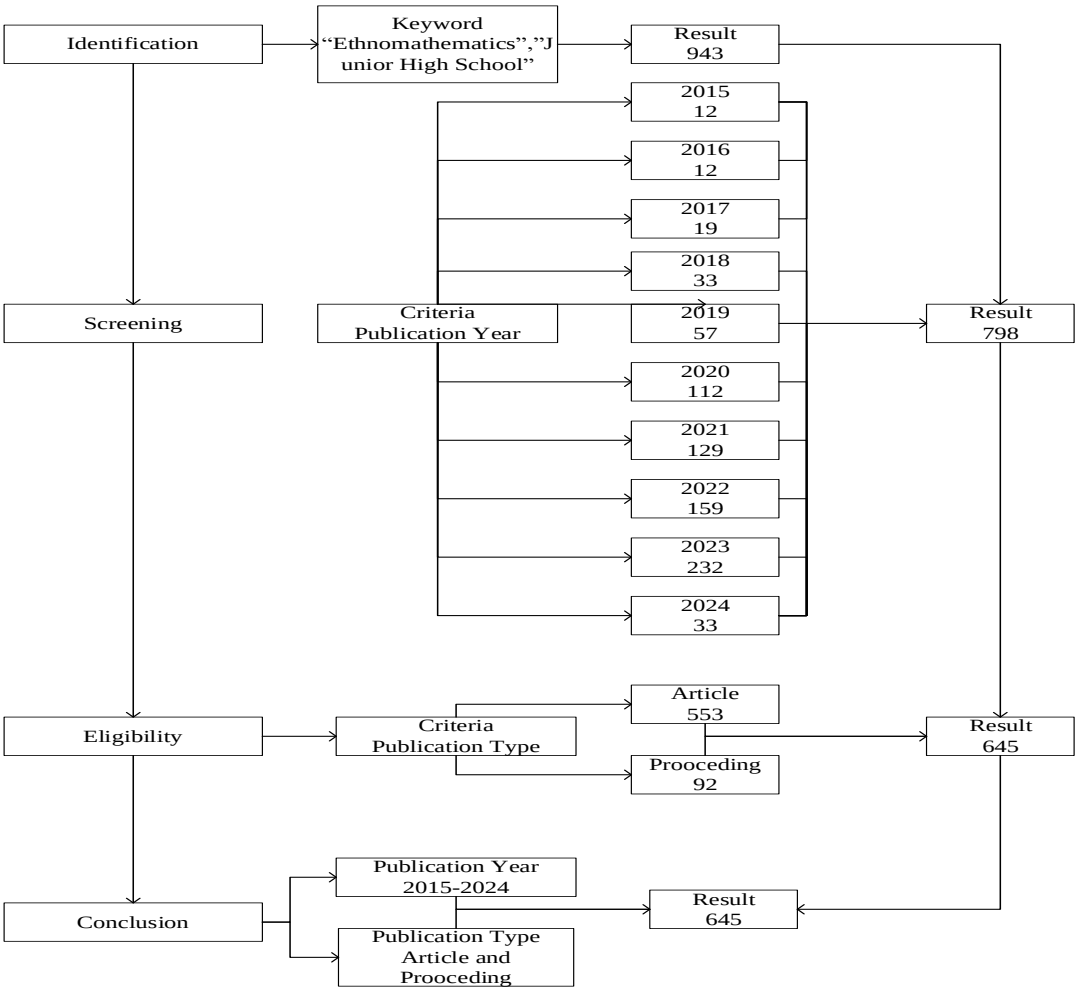

Figure 1. Data Collection Techniques

The main instrument used is the Dimension AI database to collect data on scientific publications related to ethnomathematics in junior high schools. In addition, software such as VOSviewer and Microsoft Excel are used for bibliometric analysis and data manipulation. The analysis technique was carried out qualitatively bibliometrically using several supporting software, namely Vosviewer, Microsoft Excel, and web Dimension AI. Vosviewer is software used for visualization and analysis of scientific networks. Microsoft Excel is used for basic statistical data analysis and data manipulation. Dimension AI is used as the main data source and to access additional information about scientific publications. The data used in this study was taken on March 9, 2024.

3. FINDINGS AND DISCUSSION

The data produced until the analysis stage showed that 85.5% (553 data) were in the form of articles, and 14.5% (92 data) were in the form of proceedings. Of the total 645 data collected, all of these data have gone through a validation process and are worthy of analysis. When viewed from the distribution of published years, it can be seen in Table 1.

Table 1. Dissemination of data based on the year of issue

Publication Year	Amount of Data	Percent
2015	2	0.3%
2016	5	0.8%
2017	7	1.1%
2018	21	3.3%
2019	42	6.5%
2020	79	12.3%
2021	122	18.9%
2022	149	23.1%
2023	190	29.5%
2024	28	4.3%
Total	645	100%

3.1 Influential Authors on Ethnomathematical Topics

The results obtained from Dimensions AI, the author's search for influential ethnomatmatic figures, such as Ratu Ilma Indra Putri, Sutama, Wahyu Widada, and others can be seen in Figure 2.

Name Organization, Country	↓Publications	Citations	Citations mean
Ratu Ilma Indra Putri Sriwijaya University, Indonesia	12	47	3.92
Sutama Muhammadiyah University of Surakarta, Indonesia	9	9	1.00
Wahyu Widada University of Bengkulu, Indonesia	9	45	5.00
Nuqthy Faiziyah Muhammadiyah University of Surakarta, Indonesia	9	0	-
Mega Teguh Budiarto State University of Surabaya, Indonesia	9	20	2.22

Figure 2. Influential Authors

Ratu Ilma Indra Putri recorded 12 publications that were cited 47 times during a given period, with an average citation reaching 3.92. On the other hand, Wahyu Widada also has a significant influence with 9 publications, but has a higher citation average, reaching 5.00. Meanwhile, Mega Teguh Budiarto with 9 publications also recorded an average citation of 2.99. All this shows the diverse contributions of researchers in the topic of ethnomatmatics. Not only that, this topic also began to attract a lot of attention from academics and other researchers, indicating the importance of this field in the development of science.

One interesting research from Ratu Ilma entitled "Students' problem-solving ability in solving algebra tasks using the context of Palembang". According to Putri et al., (2022) Palembang culture helps students understand algebraic arithmetic operations by connecting algebraic concepts with their local environment, students can better understand and apply mathematical ideas. Students in this study develop and solve problems by modeling them based on their mathematical ideas. They used a variety of problem-solving strategies, demonstrating their ability to apply mathematical concepts to practical situations with the help of the culture that developed in Palembang ranging from musical instruments, batik patterns and others.

While Widada et al., (2020) In "Overcoming the difficulty of understanding systems of linear equations through learning ethnomathematics" states that students' difficulties in understanding systems of linear equations can be overcome through ethnomathematical learning. Horizontal mathematization uses the fisherman culture of the Bengkulu people which reads "fish bound, rice as small as coconut milk". This culture makes it easier for students to remember prerequisite concepts, making it easier for them to make connections between concepts. This makes it easier for students to achieve the principles of elimination, substitution, and mixture.

Both studies show that culture has an important role in learning mathematics, because it can help students in several crucial ways. First, culture can help students understand maths better, because cultural context provides deeper relevance and meaning to mathematical concepts. Second, culture allows students to connect mathematical concepts with the real world, making learning more concrete and easy to understand. In addition, culture can also help students develop creative and effective problem-solving strategies. Teachers play a key role in utilizing culture in mathematics learning, both by introducing cultural context in subject matter and using methods such as horizontal mathematization to connect culture with mathematical concepts. The use of culture in mathematics learning not only enriches students' learning experience, but also helps them in understanding difficult mathematical concepts. The use of culture in mathematics learning is called ethnomathematics.

3.2 Country Coupling Bibliography

Analysis using VOSviewer revealed significant collaboration between countries on the topic of Ethnomathematics at the Junior High School level. Results showed that of the 645 data analyzed, only 23 countries were eligible with at least one document and one citation, out of a total of 29 countries investigated. From the eligible countries, 7 closely connected clusters were formed, involving 22 countries in more intensive cooperation. This analysis provides a more systematic picture of the pattern of international collaboration in Ethnomathematical research at the Junior High School level. This can be seen from Figure 3 of the relationship of countries on the topic of Ethnomathematics in junior high school.

Figure 3. Country Coupling Bibliography

Cluster 1, marked in red, stands out with the presence of 9 countries. Indonesia, as one of the countries incorporated in it, shows dominance in this cluster, along with other countries such as Malaysia, Thailand, and Vietnam. Cluster 2, where China is dominant, consists of 6 countries, while Cluster 3, dominated by the United Kingdom, involves 3 countries. Meanwhile, Clusters 4 to 7 each comprise only one country.

Indonesia stands out as the most prominent country in this analysis, mainly because of the dominance of the red cluster that is the container for this country. By having relationships with all countries in this study, Indonesia demonstrates significant collaborative advantages. This happens because of Indonesia's rich culture which includes diverse ethnic aspects and rich traditional mathematical backgrounds. Indonesia's strong presence in this analysis may reflect the global importance of ethnomathematical research at the Junior High School level as well as the collaborative potential it offers. Publication on ethnomathematics itself The trend of publications on ethnomathematics in mathematics learning in Indonesia shows an increase every year during the period studied (Muhammad & Marchy, 2023). At Muhammad & Marchy, (2023) suggesting the development of fun ethnomathematics modules with elements of videos and games becomes an important need in the context of mathematics education. This is because there is still a lack of development of learning media on ethnomathematical topics.

3.3 Document Coupling Bibliography

VOSviewer images provide an interesting overview of document collaboration in this analysis. Of the total 645 publication data analyzed, by setting a threshold of one citation, only 301 of them qualified. Of these, only 204 were connected, demonstrating the complexity and density of the collaboration network between the documents involved in the study. This indicates significant engagement between different research sources, as well as the potential to reveal deeper patterns and trends of collaboration in this analysis. This can be seen from Figure 4 below.

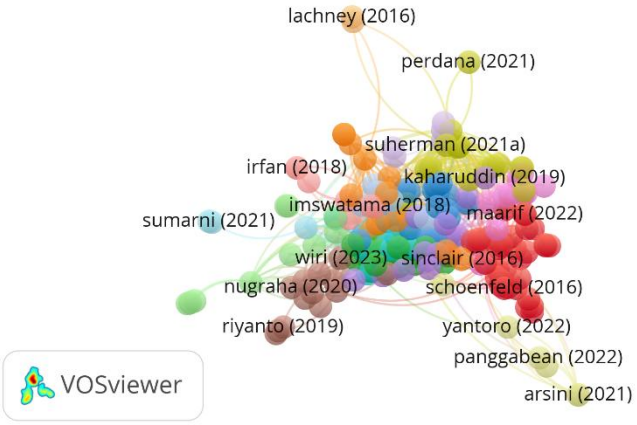

Figure 4. Document Coupling Bibliography

Figure 4 illustrates the diversity of clusters in research on ethnomathematical topics in junior high schools, represented by various colors. There are 16 interconnected clusters, with the red cluster being the largest and most prominent, indicating a strong focus on ethnomathematics at the junior secondary level. According to Mumpuni and Marsigit (2022), the ethnomathematics approach is still rarely applied in Indonesian schools, particularly at the junior high school level. At this stage, students are transitioning from the concrete learning experiences of primary school to more abstract concepts in secondary education. The mathematical problems they encounter require strong representational skills, as effective representation is a key foundation for understanding and solving problems.

Similarly, Supriyadi et al. (2022) investigated the limited exploration of ethnomathematics in Indonesia, especially regarding the development of learning media. Ethnomathematical media can enhance students' thinking skills and their understanding of complex concepts. Lachney et al. (2021) also noted that computational thinking skills in students can be improved through the use of an ethnomathematical approach.

Another identified cluster focuses on the development of mathematics learning media that integrates ethnomathematics and Lampung culture using the Powtoon application (Choirudin et al., 2020). The study found that such media is feasible for classroom use and has a positive impact on learning outcomes among junior high school students.

3.4 Research Focus

Through analysis using VOSviewer, 19 clusters were identified, consisting of 119 keywords relevant to ethnomathematics at the junior high school level. The number of words in each cluster varies, with the Red cluster having 13 words, the Green cluster with 12 words, the Blue cluster with 9 words, the Yellow cluster with 9 words, the Purple cluster with 8 words, the Light Blue cluster with 7 words, the Orange cluster with 7 words, and the Brown cluster with 7 words, as well as several other smaller clusters. Each cluster shows a different research focus, covering various aspects of ethnomathematics at the junior high school level. This analysis provides a more detailed picture of keyword distribution and research focus in this area, as shown in Figure 4.

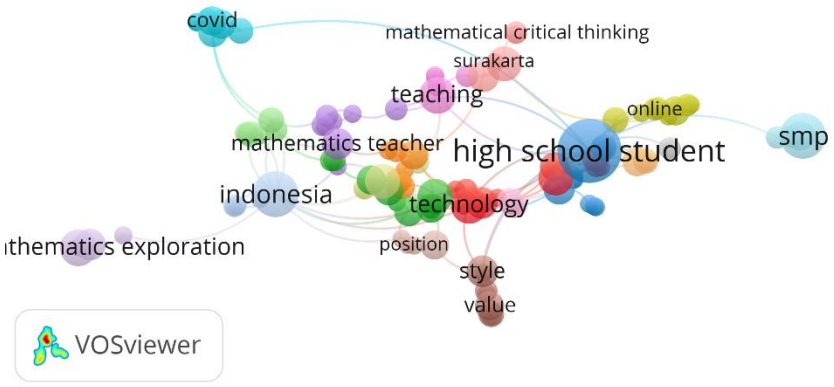

Figure 4. Research Focus

Cluster 1 shows the focus of research involving the three main keywords technology, ethnomathematics, and batik. Technology is often an important part of modern ethnomathematical approaches, enabling the integration of technology in mathematics teaching and learning by utilizing tools such as software, applications, and online platforms (A'yuni, 2020). Ethnomathematics itself is a field of study that combines mathematics with cultural aspects, and batik is one aspect of Indonesian culture that is rich in mathematical values. Analysis of these three keywords shows an interest in exploring the potential of technology in the context of ethnomathematics, as well as its application in local cultural contexts such as batik.

Cluster 2 highlights two main keywords: mathematical communication skills and assessment. The application of technology in improving students' mathematical communication skills, as well as in their assessment or evaluation process (Gusvarini et al., 2022). The use of technology, such as digital media or interactive software, can help students to develop their mathematical communication skills in a more effective way (Ayni et al., 2023). In addition, technology can also be used to simplify the assessment process and provide faster and more targeted feedback to students.

Cluster 3 emphasizes two main keywords junior high school and math concepts. Analysis of these keywords shows the focus of research on understanding mathematical concepts at the junior high school level. The use of ethnomathematical approaches, which include cultural and local aspects, to support students' understanding of mathematical concepts. The integration of local cultures, as exemplified by the research in cluster 1, can help students to better connect with mathematical material and improve their understanding.

Novelty found among these keywords is the need to develop ethnomathematical learning media that utilize technology. In this context, the learning media developed has the potential to improve several important aspects, especially in developing the necessary capabilities in the 21st century (Fauzan et al., 2021). First, the use of technology in ethnomathematics learning media can improve students' technological skills. By interacting with media designed with advanced technology, students can get used to the use of digital tools and online platforms, which is a very important skill in today's digital age. Second, learning media that utilize technology can improve students' critical thinking and problem-solving skills. The use of technology often involves challenges and interactions that require creative and analytical thinking to solve the problems at hand, thus strengthening students' critical thinking skills. Third, technology-based ethnomathematics learning media can also improve students' collaboration and communication skills. In interactive learning, students are often given the opportunity to collaborate with their peers online, share ideas, and communicate in effective ways, which are essential skills in a modern and global work environment. The development of ethnomathematical learning media that utilizes technology not only provides innovation in education, but also improves students' preparation to face the demands and challenges of the 21st century (Aulia et al., 2021).

4. CONCLUSION

Ethnomathematics research at the junior high school level is showing positive development, with Indonesia emerging as the leading country in this field. This prominence is driven by Indonesia's rich cultural and traditional mathematical heritage, as evidenced by its dominance in the red cluster involving nine countries. The trend of publications on ethnomathematics in mathematics learning, particularly in Indonesia, demonstrates consistent growth over the past decade, highlighting a rising interest and recognition of its potential in improving educational practices. However, despite these advancements, there are still gaps that need to be addressed, particularly in the development of engaging and interactive ethnomathematics learning media. Current resources lack the integration of multimedia elements such as videos, games, and simulations, which are crucial for enhancing students' learning experiences and motivation. Future research should prioritize the creation of comprehensive ethnomathematics modules that incorporate innovative multimedia tools. These resources can connect mathematical concepts with cultural contexts while simultaneously fostering critical 21st-century skills, such as technology literacy, critical thinking, problem-solving, collaboration, and communication. Additionally, researchers should explore the adaptation of ethnomathematics to diverse cultural settings and evaluate its impact on student learning outcomes across different regions. The findings of this study have significant implications for educational practices and policies. Policymakers are encouraged to integrate ethnomathematics into the school curriculum to promote cultural awareness, preserve local traditions, and enhance students' mathematical understanding. By embedding ethnomathematics into education, schools can create a more inclusive and contextually relevant learning environment that prepares students for global challenges while preserving their cultural heritage.

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