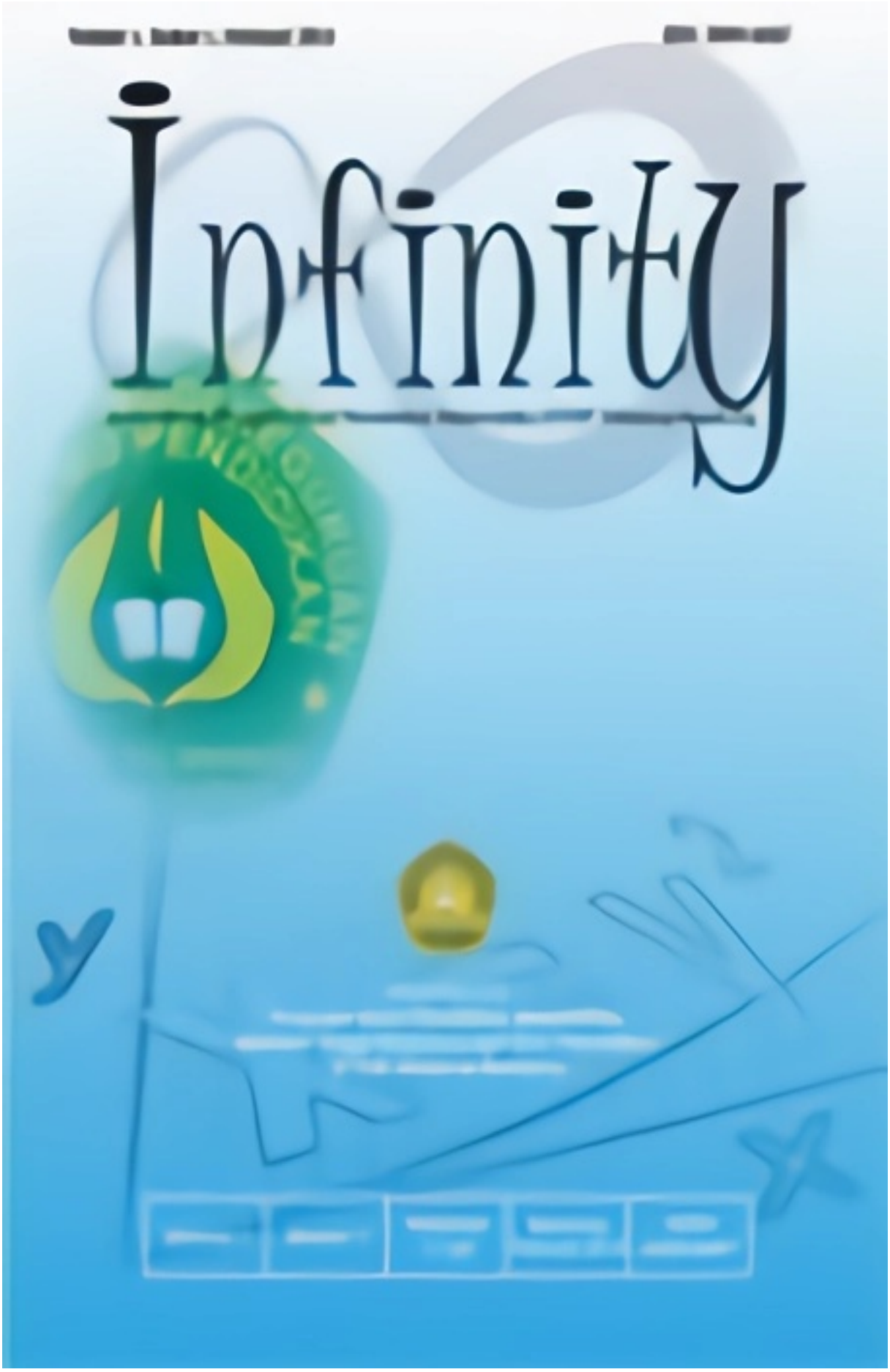
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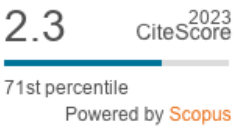

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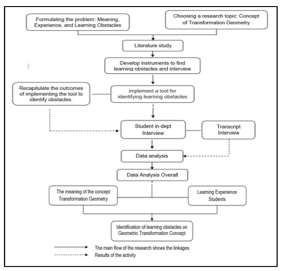

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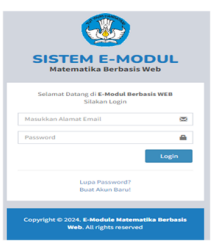

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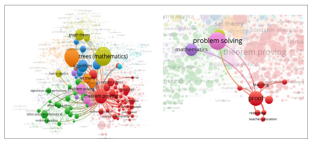

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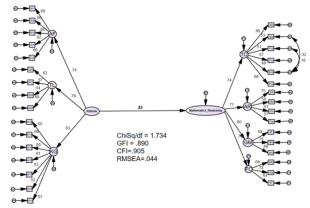

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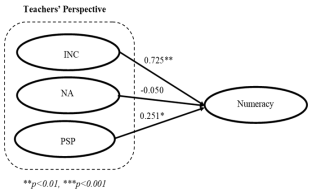

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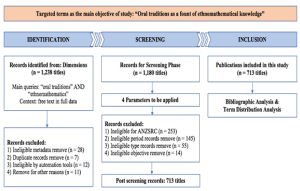

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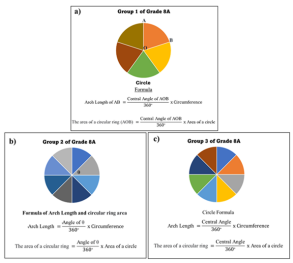

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Oral traditions as a fount of ethnomathematical knowledge: A bibliometric analysis of contemporary research trends

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Abstract

This study mapped the contemporary research landscape surrounding "oral traditions as a fount of ethnomathematics knowledge" through a bibliometric analysis employed as a methodological procedure. The main problem addressed in this study is the lack of a comprehensive consideration of evolving research trends and intellectual structure within ethnomathematics, i.e., the role of oral traditions as a source of knowledge. Oral traditions, defined as the cultural knowledge, art, ideas, and practices transmitted verbally across generations, offer a rich repository of ethnomathematical insights. 713 publications were identified from the Dimensions database between 2014 and 2024. This bibliometric analysis focused on identifying key research themes, authors, publishers, keywords, or key terms distributions within the corpus of extracted publications, as well as temporal trends in publication activity and citation patterns. The findings revealed a growing interest in the field, focusing on (a) educational context, (b) cultural studies, and (c) the intersection of mathematics and language. The analysis also identified key research themes, such as (a) the role of language and culture in shaping mathematical thought, (b) the development of ethnomathematical practices, and (c) the pedagogical implications of incorporating ethnomathematics into formal education. Additionally, 11 influential scholars who are driving the field forward were identified. According to the term distribution analysis, of the 6,092 terms, 316 met the threshold (minimum number of occurrences of the term: 6). For each 316 terms, a relevance score has been calculated. Based on this score, the most relevant terms have been selected. The VOSviewer's default setting (60% of the most relevant terms) resulted in selecting 190 terms. Based on the given criteria, there is a result of 5 distinctive clusters related to the query that emerged. This study provides theoretical insights into the conceptual foundations of ethnomathematics derived from oral traditions and empirical evidence for informing future research directions and pedagogical practices in mathematics education.

Keywords:
Bibliometric analysis, Ethnomathematical knowledge, Interdisciplinary inquiry, Oral traditions, Research trends

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1. INTRODUCTION

The intersection of mathematics and culture has long been a subject of scholarly inquiry, with a growing recognition of the diverse ways in which mathematical ideas are embedded within specific socio-historical contexts (D'Ambrosio, 1978, 2018; Pinxten, 2016; Rosa & Orey, 2021). In recent decades, the theoretical framework of ethnomathematics has emerged as a lens for examining the relationship between mathematics and cultural practices (Cordero et al., 2024; Rosa & Orey, 2024). Ethnomathematics posits that mathematical concepts are not universal but are shaped by specific cultural values, beliefs, and worldviews (Ascher, 2017; François & Pinxten, 2011). It recognizes the diversity of mathematical thought systems and practices across different societies. It also acknowledges that mathematical ideas are not simply abstract concepts but are shaped by cultural values, such as collectivism versus individualism, and by ecological factors, such as the availability of natural resources. Therefore, ethnomathematics emphasizes the importance of studying mathematics within its cultural context, rather than as separate, abstract domain (Ascher & Ascher, 1986; D'ambrosio, 2020). Different cultures have developed unique ways of understanding and applying mathematical ideas, reflecting their particular historical, social, and ecological circumstances. In short, ethnomathematics seeks to uncover and appreciate these diverse mathematical practices, recognizing that they are not merely variations on a universal theme but rather distinct and valuable contributions to the broader field of mathematics.

Oral traditions, as repositories of cultural heritage, offer a rich and multifaceted source of ethnomathematical knowledge (Wagner, 2015; Wagner et al., 2024). Oral traditions, defined as the cultural knowledge, art, ideas, and practices transmitted verbally across generations, offer a rich repository of ethnomathematical insights (Finnegan, 2004, 2020; Ritchie, 2012). These traditions, transmitted through generations, encapsulated sophisticated mathematical ideas and practices that have evolved over centuries. By analyzing oral narratives, researchers can uncover hidden mathematical structures, algorithms, and problem-solving strategies that have been developed and transmitted within specific cultural contexts (Morgan et al., 2014). One of the primary benefits of analyzing oral traditions is the ability to identify mathematical concepts that may not be explicitly stated or recognized as such. These concepts can be embedded in various linguistic structures, such as metaphors, similes, and counting systems (Farsani et al., 2022). For instance, the use of spatial metaphors to describe numerical quantities or geometric patterns can reveal underlying mathematical reasoning. By examining these linguistic devices, researchers can uncover the cognitive processes and cultural values that shape mathematical thought. In addition to uncovering hidden mathematical structures, analyzing oral traditions can also reveal innovative problem-solving strategies. These strategies may be embedded in traditional stories, myths, or rituals. By examining these narratives, researchers can identify creative approaches to mathematical challenges that may not be found in formal mathematical education (Lange & Meaney, 2017). These strategies can offer valuable insights into the diverse ways in which humans have engaged with mathematical problems and developed solutions.

Several scholars have contributed significantly to the developing ethnomathematics and the study of cultures as sources of mathematical understanding. D'Ambrosio is one of the pioneers in the field, advocating for a more inclusive and culturally sensitive approach to mathematics education (D'Ambrosio, 1989, 1995). Ascher has extensively researched the mathematical ideas embedded in indigenous cultures, particularly those of non-western cultures (Ascher, 1984, 1997). Gerdes has focused on the mathematical practices of African cultures, highlighting the rich and diverse mathematical knowledge found in oral traditions (Gerdes, 2004, 2005, 2015). Recent studies have explored the ethnomathematical aspects of various oral traditions, including indigenous storytelling, counting systems, and geometric patterns. Pinxten, François, and Vandendriessche examined the mathematical concepts embedded in the traditions of the Indian Canyon people amongst other indigenous communities (Pinxten & François, 2011; Vandendriessche & Pinxten, 2022). Otte (2019) analyzed the mathematical ideas of time and space present in the histories of the Western Paleolithic age. Rosa and de Oliveira investigated the ethnomathematical knowledge of the people of South America (Rosa, 2020; Rosa & de Oliveira, 2020). Prahmana et al. (2021) revealed an exciting ethnomathematics analysis concerning pranatamangsa system and the birth-death ceremony in Yogyakarta, Indonesia (cf. Prabowo, 2021; Prabowo et al., 2022; Utami et al., 2019, 2020). Also, Kucheriavyi's (2022) noteworthly study, which analyzed the design of didactic materials based on fairy tales to enhance proactive mathematics learning in primary schools, provides a compelling example of fostering children's interest in the natural world and promoting proactive, natur-based learning through narrative engagement. Previously, Maričić et al. (2018) pointed out the necessity and potential for incorporating children's literature into preschool math education. In addition to these specific studies, several scholars have conducted bibliometric analysis to map the broader research landscape of ethnomathematics. Deda et al. (2024) by a bibliometric analysis of the global trend of ethnomathematics studies of the last decade (2012 – 2022) according to the Scopus and Google Scholar databases, Lidinillah et al. (2022) by a systematic reviewing the integration of Sundanese ethnomathematics into mathematics curriculum and teaching, and Kusuma et al. (2024) by exploring the ethnomathematics research in Indonesia during 2010 to 2023 according to Google Scholar database.

However, despite the growing interest in ethnomathematics, a brief description of the contemporary research landscape remains elusive, especially for the descriptive analysis of the relations between "oral traditions" and "ethnomathematical knowledge" from their global perspective. Methodologically, the objective of the relationship between these two key terms has not been analyzed in the frame of bibliometrics by using the latest tool, VOSviewer (1.6.20) (van Eck & Waltman, 2023), according to the globally open access database, Dimensions. This study thus employes a novel methodological approach by leveraging the advanced functionalities of VOSviewer to ma the intellectual structure of this emerging field with unprecendented precision. Furthermore, it contributes to the theoretical development of ethnomathematics by systematically analyzing the global research trends related to oral traditions, offering a comprehensive and up-to-date overview of this dynamic interdisciplinary domain. This study aims to address this gap by conducting a bibliometric analysis of the recent research trend related to "oral traditions as a fount of

ethnomathematical knowledge". Bibliometrics, a quantitative research approach, involves the statistical analysis of bibliometric data, such as publications, citations, and keyword networks. By examining these metrics, we can identify key trends, patterns, and influential contributors within the field. Accordingly, the research questions of the present study are: (a) what are the emerging trends and patterns in the research on oral traditions and ethnomathematics, as evidenced by the bibliometric analysis of contemporary literature, (b) how has the interdisciplinary nature of ethnomathematics evolved over time (2014 – 2024), as reflected in the analyzed corpus of literature, and (c) what are the key term-networks shaping the discourse on oral traditions and ethnomathematics, and how do these networks contribute to further research directions?

2. METHOD

2.1. Study Design

This study employs a bibliometric approach to investigate the contemporary research trends related to "oral traditions as a fount of ethnomathematical knowledge." Bibliometrics is a quantitative research method that utilizes statistical techniques to analyze scholarly publications. In this study, bibliometric techniques were used to identify key publications, authors, journals, and institutions involved in the study of ethnomathematics and oral traditions. Citation analysis was conducted to assess the impact and influence of specific publications and researchers within the field. Co-authorship analysis was employed to identify collaborative networks and potential research communities. Additionally, keyword analysis was performed to extract the most frequently used terms and concepts associated with the research topic.

2.2. Material

The data for this study was extracted from Dimensions (see Figure 1), a comprehensive academic resource that provides access to a vast corpus of scholarly literature. 713 titles were identified using the query terms. The extracted data included the document type, publication year, author(s), title, abstract, keywords, and citation count. The document classifications identified in the dataset included journal articles, book chapters, monographs, and edited books, reflecting the diverse formats in which research on oral traditions and ethnomathematics is published.

To be Included in the analysis, publications had to meet several key criteria. First, they needed to be identified within the Dimensions database using the search terms "oral traditions" AND "ethnomathematics" within the full text of the publications. This ensured that the selected studies explicitly addressed the intersection of these two concepts. Second, publications had to be classified within a relevant field of study according to the Australian and New Zealand Standard Research Classification (ANZSRC) 2020 codes. This ensured thematic relevance to the research question. Finally, only publications that explicitly focused on oral traditions as a source of ethnomathematical knowledge were included, further refining the scope of the analysis.

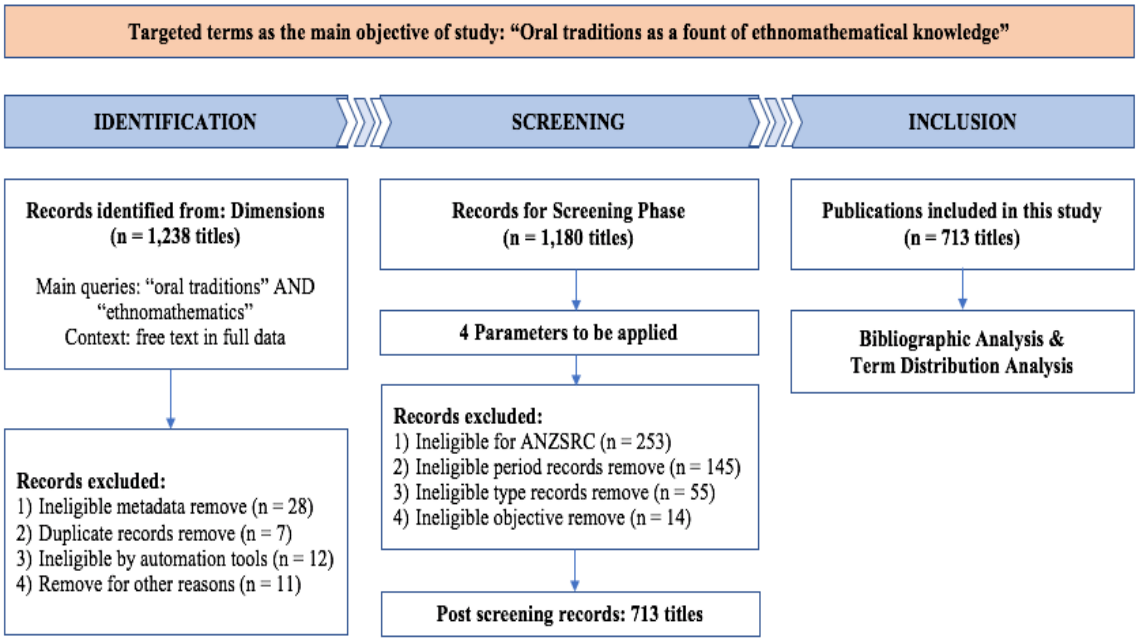


Figure 1. Flow chart of the present bibliometric study on "oral traditions as a fount of ethnomathematical knowledge" (Page et al., 2021)

Several criteria were employed to exclude irrelevant publications from the analysis. Records were excluded if they had ineligible metadata, were duplicates, or were deemed ineligible by automation tools. Additionally, publications outside the specified timeframe (2014 – 2024) were removed to ensure the analysis captured contemporary research trends. Studies that did not align with the ANZSRC codes or did not specifically address the research objective of exploring oral traditions as a source of ethnomathematical knowledge were also excluded. This rigorous screening process aimed to refine the dataset and ensure that only the most relevant publications were included in the subsequent analysis.

2.3. Procedure for Data Collection and Analysis

The present study involves several key steps (see Figure 1). First, database selection. Dimensions, an open access and comprehensive academic database, was chosen as the primary source for data collection due to its extensive coverage of scholarly literature across various disciplines. Second, search term formulation. A set of carefully selected keywords, including "oral traditions" and "ethnomathematics" were used to identify relevant publications. Only four types of publications were selected, such as journal articles, book chapters, monograph, and edited book, published during 2014 to 2024. Third, data extraction. Bibliographic information, such as publication year, authors, title, abstract, keywords, and citation count, was extracted from the selected publications. The extracted metadata was imported as *.csv file type as preparation for the next step of the study. This was the post screening records that meet the standard for the inclusion process. Fourth, data analysis. By using VOSviewer (1.6.20), a variety of bibliometric techniques were employed to analyze the extracted data. These include co-authorship analysis to identify collaborative networks, keyword analysis to explore research themes, and citation analysis to assess the

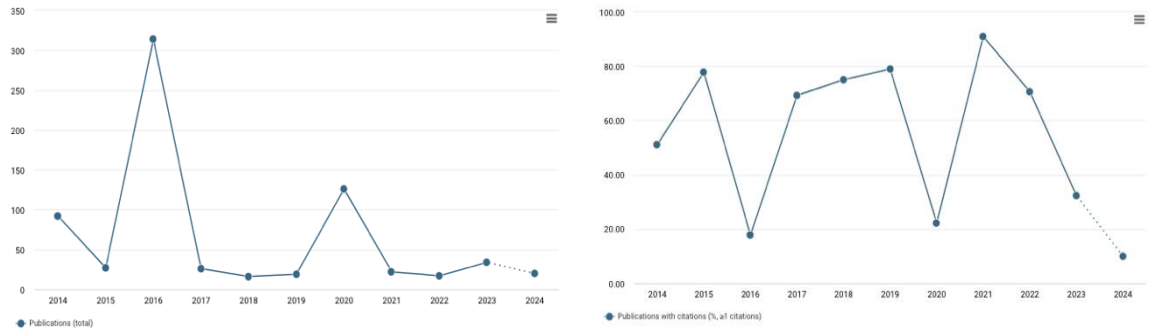
impact of publications. The ANZSRC 2020's code has been implemented to classify the research domain amongst all examined publications. ANZRC is a standardized parameter to categorize research work based on the Australian Bureau of Statistics. This system is one of the options of Dimension that facilitates users to deal with the analysis. Lastly, the results were visualized using appropriate data visualization tools of VOSviewer to enhance understanding and facilitate interpretation.

3. RESULTS AND DISCUSSION

3.1. Results

Yearly Publication

Concerning the yearly publication, Figure 2(a) provides a quantitative overview of the publication output related to "oral traditions as a fount of ethnomathematical knowledge" from 2014 to 2024. The data reveals significant fluctuations in the annual number of publications. A notable peak in publication activity occurred in 2016, followed by a sharp decline in 2017 and 2018. Subsequently, there was a resurgence in 2020, which continued into 2021. These fluctuations suggest that research interest in the field has been sporadic, with periods of heightened activity interspersed with intervals of relative quiescence. Such patterns may be attributed to various factors, including the availability of funding, shifts in research priorities, or the emergence of new theoretical frameworks.



(a) (b)

Figure 2. The yearly publication of "oral traditions as a fount of ethnomathematical knowledge" (2014 – 2024): (a) Depiction of all publications concerning the search query without their impact or citation; (b) The statistical presentation of publications with their impact

Moreover, Figure 2(b) complements the publication data by presenting the percentage of publications with at least one citation for each year from 2014 to 2024. The data indicates considerable variation in the proportion of cited publications across the period analyzed. While some years, such as 2015 and 2021, exhibit relatively high percentages of cited publications, others, like 2016 and 2020, show significantly lower rates. These disparities may reflect differences in the overall quality of research output, the speed at which research findings are disseminated and adopted, or the time lag between publication and citation. It is essential to note that a high percentage of cited publications does not necessarily equate to high-impact research, as a single citation per publication might not

indicate substantial influence. Nevertheless, this metric provides a preliminary indication of the potential impact of research within the field.

Citation Frequency

Figure 3 presents a chronological overview of the cumulative citation count for publications related to "oral traditions as a fount of ethnomathematical knowledge" from 2014 to 2024. This data offers a quantitative perspective on the trajectory of scholarly attention and impact within the field. A cursory examination reveals a generally upward trend in citations over the decade, suggesting growing interest and engagement with the research topic. The data indicates a period of substantial growth between 2014 and 2022, with notable acceleration in citation accumulation during these years. This suggests a burgeoning research community and increasing recognition of the field's significance.

A closer inspection of the citation data unveils fluctuations in the annual growth rate. While the overall trend is positive, there are periods of accelerated growth interspersed with years of more modest increases. Such variations might be attributed to several factors, including the publication of high-impact studies, shifts in research priorities within the broader academic landscape, or external events influencing research productivity. The pronounced increase in citations in 2020 is particularly noteworthy and could be linked to the global COVID-19 pandemic, which may have altered research focus and output. Additionally, the decline in citations observed in 2024 warrants further investigation to identify potential causes, such as changes in publication patterns or shifts in research interests.

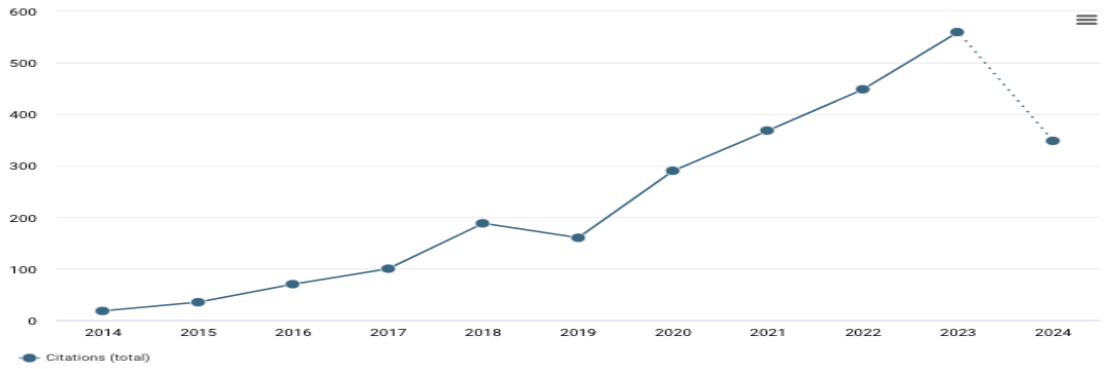
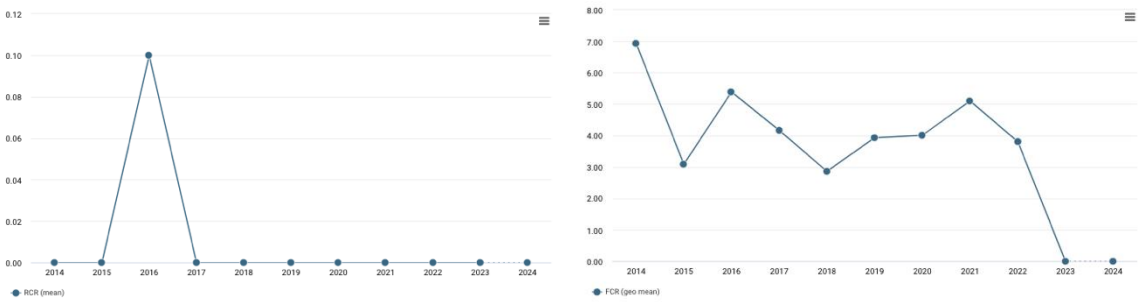


Figure 3. The yearly citation frequency from 2014 to 2024 of publications related "oral traditions as a fount of ethnomathematical knowledge"

Moreover, Figure 4(a) presents the mean Relative Citation Ratio (RCR) for publications related to the searched query. The RCR is a metric that compares the citation performance of a publication to other publications in the same research field. A striking feature of the data is the consistently low RCR values across all years, with most years reporting an RCR of zero. This suggests that the publications in this field have underperformed in comparison to their peers. Several interpretations are possible: the field may be relatively new and emerging, with publications requiring more time to accumulate citations; the field might be niche, with a smaller potential audience and consequently influential or groundbreaking. Further investigation into the characteristics of the

publications in this field is necessary to elucidate the underlying causes of the low RCR values.



(a) (b)

Figure 4. Publication impact of "oral traditions as a fount of ethnomathematical knowledge" (2014 – 2024) as measured by citation counts: (a) The mean relative citation ratio (RCR); (b) The geometric mean field citation ratio (FCR)

Figure 4(b) displays the geometric mean Field Citation Ratio (FCR) for publications related to the examined query of the present study. The FCR provides a measure of a publication's citation performance relative to other publications of similar age within the same subject area. While there is some fluctuation in the FCR values across the years, the overall trend indicates a moderate level of citation impact. The FCR values generally range from 2 to 6, suggesting that the publications in this field are citing and being cited at a rate comparable to another research in the same domain. However, the decline in the FCR towards the end of the period is noteworthy and warrants further exploration. This could be attributed to various factors, such as changes in publication practices, shifts in research focus within the field, or external influences on citation behavior.

Research Domains

Table 1 offers a quantitative overview of the most prolific fields of study associated with "oral traditions as a fount of ethnomathematical knowledge" between 2014 and 2024. The data is structured around eleven distinct fields, each categorized by its ANZSRC 2020 code. For each field, the table provides a breakdown of the total number of publications, the aggregate number of citations received, and the mean number of citations per publications. Dominated by the education domain, with subfields like Curriculum and Pedagogy, Education Systems, and Specialist Studies in Education securing prominent positions, the data indicates a strong pedagogical interest in exploring the intersection of oral traditions and mathematics. Notably, the high citation mean for Specialist Studies in Education suggests that the research within this niche has been particularly influential. While Language, Communication and Culture, and Cultural Studies also contribute significantly to the corpus, their overall publication output is lower compared to education-focused areas. A surprising inclusion is Mathematical Sciences, despite a minimal publication count, highlighting the potential for future explorations in this domain.

Table 1. The eleven most popular study area related to the "oral traditions as a fount of ethnomathematical knowledge" from 2014 to 2024

Field of study	ANZSRC 2020's Code	Publications	Citations	Citations (mean)
Education	39	112	1,302	11.63
Curriculum and Pedagogy	3901	77	862	11.19
Education Systems	3903	76	792	10.42
Language, Communication and Culture	47	37	281	7.59
Cultural Studies	4702	22	203	9.23
Specialist Studies in Education	3904	18	318	17.67
Creative Arts and Writing	36	16	78	4.88
Linguistics	4704	4	36	9.00
Mathematical Sciences	49	3	8	2.67
Language Studies	4703	2	29	14.50
Applied Mathematics	4901	1	4	4.00

A closer examination of the citation data reveals interesting patterns of scholarly impact. While Education emerges as the most prolific field, its average citation per publication is moderate. In contrast, Specialist Studies in Education exhibits a significantly higher citation mean, suggesting that research within this area has been particularly influential. The relatively high citation mean for Language Studies, despite a small publication count, underscores the potential impact of research in this domain. Conversely, fields such Creative Arts and Writing, and Mathematical Sciences, while contributing to the overall corpus, demonstrate lover citation rates, indicating potentially less influential research output. These findings suggest that while exploration of oral traditions and ethnomathematics is gaining traction across multiple disciplines, the fields intellectual core and impact are concentrated in specific areas, primarily within education and cultural studies.

Moreover, the prominence of Education as the most prolific field of study within the research landscape of "oral traditions as a fount of ethnomathematical knowledge" is multifaceted. As evidenced in the Table 1, Education boasts the highest number of publications (112) and citations (1,302) with a respectable mean citation rate of 11.63. This dominance can be attributed to several interconnected factors. Firstly, ethnomathematics, by its very nature, seeks to bridge cultural knowledge and mathematical understanding, making it inherently relevant to educational contexts. Exploring oral traditions as a source of ethnomathematical knowledge offers educators valuable insights into culturally relevant pedagogy, allowing them to connect mathematical concepts with students' lived experiences and cultural heritage. This approach resonates with constructivist learning theories and culturally responsive teaching practices, both of which emphasize the importance of building upon learners' prior knowledge and cultural backgrounds. Secondly, incorporating oral traditions into mathematics education can promote inclusivity and equity by recognizing and valuing diverse ways of knowing and doing mathematics. This aligns with broader educational goals of fostering cultural understanding and appreciation within the classroom. Finally, the emphasis on oral traditions within ethnomathematics research naturally

intersects with pedagogical inquiries into language, storytelling, and intergenerational knowledge transmission, all of which are central to educational research and practice.

Publisher Sourcing

Table 2 provides a comprehensive overview of the top eleven publishers contributing to the field of "oral traditions as a fount of ethnomathematical knowledge" between 2014 and 2024. The data is organized by publisher name, with corresponding metrics for the total number of publications, overall citations, and mean citations per publication. A cursory analysis reveals a diverse range of publishers, spanning disciplines such as education, mathematics, and social sciences. This suggests that the study of oral traditions in relation to ethnomathematics is a multifaceted endeavor, drawing on multiple academic perspectives. A notable observation is the disparity in publication output and citation impact among publishers. While some journals, such as Canadian Journal of Science, Mathematics and Technology Education, demonstrate a relatively small number of publications but a significantly high mean citation per publication, others, like Advances in Social Science, Education and Humanities Research, present a higher publication count but lower citation impact. This indicates varying levels of influence and scholarly attention within the field.

Table 2. The top eleven publishers that are related to the "oral traditions as a fount of ethnomathematical knowledge" from 2014 to 2024

Publications Name	Publications	Citations	Citations (mean)
Advances in Social Science, Education and Humanities Research	5	3	0.60
Historia Mathematica	3	5	1.67
Canadian Journal of Science, Mathematics and Technology Education	3	45	15.00
Intercultural Education	2	6	3.00
ZDM – Mathematics Education	2	4	2.00
History of Mathematic Education	2	19	9.50
Advances in Innovation Education	2	13	6.50
Journal of Mathematics and Science Teacher	2	13	1.50
L Homme	2	5	2.50
Advances in Innovation Education	2	13	6.50
Research in Mathematics Education	1	6	6.00

Delving deeper into the data, it becomes apparent that the field is characterized by a mix of specialized and interdisciplinary journals. Publications like Historia Mathematica and History of Mathematics Education focus on the historical dimensions of mathematics, while journals such as Canadian Journal of Science, Mathematics and Technology Education and ZDM – Mathematics Education concentrate on contemporary educational practices. This interplay between historical and contemporary perspectives is essential for a comprehensive understanding of ethnomathematics.

Moreover, the inclusion of journals from fields like Intercultural Education and L'Homme underscores the interdisciplinary nature of the research. These publications highlight the importance of cultural and anthropological perspectives in exploring the relationship between oral traditions and mathematics. Such interdisciplinary collaborations enrich the field by offering diverse methodological approaches and theoretical frameworks.

In conclusion, the publisher analysis provides insights into the scholarly landscape of ethnomathematics, revealing the key journals and disciplinary orientations that shape the discourse within this emerging research area.

Prominent Researcher

Table 3 offers a snapshot of the most prolific researchers contributing to the field of "oral traditions as a fount of ethnomathematical knowledge" between 2014 and 2024. The data is structured around eleven prominent scholars, providing details on their respective countries of affiliation, the number of publications, total citations, and mean citations per publications. A preliminary analysis reveals a geographic spread of researchers across multiple continents, indicating a global interest in the subject matter. Europe, with representation from Belgium, the Netherlands, and Norway, appears to be a significant hub for this research. However, scholars from Americans, including Brazil, Argentina, and the United States, also contribute substantially to the field.

Table 3. From 2014 to 2024, eleven prominent researchers were closely associated with the study of "oral traditions as a fount of ethnomathematical knowledge"

Name	Country	Publications (n > 1)	Citations (n > 3)	Citations (mean)
Rik Pinxten	Belgium	6	5	0.83
Marcel Otte	Belgium	4	4	1.00
Gustavo Gabriel Politis	Argentina	4	8	2.00
Tony Trinick	New Zealand	3	14	4.67
Daniel Clark Orey	Brazil	3	44	14.67
Milton Rosa	Brazil	3	44	14.67
Piata Allen	New Zealand	3	14	4.67
Tamsin Jillian Meaney	Norway	2	13	6.50
David Wagner	Canada	2	17	8.50
Gloria Swindler Boutte	United States	2	33	16.50
Godfried T Toussaint	United Arab Emirates	2	42	21.00

A noteworthy observation is the variation in publication output among researchers. While some scholars, such as Rik Pinxten and Marcel Otte from Belgium, have produced a relatively large number of publications, others, like Tamsin Jillian Meaney from Norway and David Wagner from Canada, have generated a smaller corpus of work. This disparity may reflect differences in research focus, career stage, or methodological approaches. Additionally, the table highlights the importance of considering citation metrics as an indicator of research impact. While publication quantity is valuable, the quality and influence of research are often better represented by citation counts.

A deeper examination of the citation data provides insights into the relative impact of different researchers within the field. Scholars such as Daniel Clark Orey, Milton Rosa, and Gloria Swindler Boutte from the Americans exhibit exceptionally high mean citation values, suggesting their work has had a considerable influence on the overall discourse. This could be attributed to groundbreaking research, influential theoretical contributions, or methodological innovations. As a further example, in their work entitled "Exploring cultural

dynamism of ethnomodelling as a pedagogical action for students from minority cultural groups," Rosa and Orey (2024) challenge the prevailing notion of universal mathematical knowledge with the globalized discourse of mathematics education. By critically examining the dominance of standardized mathematical techniques and procedures in curricula worldwide, they argue for the recognition and integration of diverse mathematical practices. Ethnomodelling is presented as a pedagogical approach that bridges the gap between local and global mathematical knowledge, fostering a "glocal" understanding that values the contributions of distinct values. In contrast, researchers with lower mean citation counts may be exploring niche areas or have published more recently, with their work yet to garner widespread attention. For instance, Vandendriessche and Pixten's work (2022) entitled "Indigenous knowledge and ethnomathematics" delves into the intricate connections between indigenous knowledge systems and the field of etnhomathematics, tracing the historical development of these intertwined domains. Recognizing the potential for enriching mathematics education globally, this work examines the multifaceted relationship between these two areas of inquiry.

Furthermore, Table 3 also offers preliminary clues about potential research foci. While a more in-depth analysis is required, the affiliations or researchers with specific journals or conferences could provide additional context. For instance, the presence of multiple researchers from Brazil with high citation counts might suggest a strong research community and a focus on indigenous knowledge systems in that region. Similarly, scholars affiliated with institutions known for their work in ethnomathematics or related fields could be identified as potential leaders in the domain.

Term Distribution Map

According to the term distribution analysis, of the 6,092 terms, 316 meet the threshold (minimum number of occurrences of term: 6). For each of the 316 terms, a relevance score will be calculated. Based on this score, the most relevant terms will be selected. The default choice is to select 60% of the most relevant terms. The number of terms to be selected is 190. Based on the given criteria, there is a result of 5 distinctive clusters related to the "oral traditions as a fount of ethnomathematical knowledge" (see Table 4). Firstly, cluster 1, characterized by terms such as "calendars", "geometry", and "mapmaking", predominantly encompasses the core concepts and applications of mathematics. The presence of terms like "curricula" and "mathematician" suggests a strong connection to formal education and the discipline of mathematics itself. The inclusion of "musical rhythm" and "scientific knowledge" hints at the broader interdisciplinary nature of mathematical thinking. This cluster, colored red in Figure 5, likely represents the foundational knowledge base upon which the field of ethnomathematics is built. Based on first cluster, several research questions for future inquiry can be develop, for instance: (a) how do traditional knowledge systems, such as calendars and mapmaking, contribute to the development of formal mathematical concepts and theories; (b) to what extent do historical applications of mathematics, like city planning and geometry, inform contemporary mathematical problem-solving and innovation; (c) how can the analysis of traditional mathematical practices, exemplified by musical rhythm, enhance our understanding of the

cognitive foundations of mathematics; (d) what are the epistemological implications of considering traditional knowledge as a source of mathematical validation and proof; and (e) how can the integration of traditional mathematical concepts into modern curricula foster a more inclusive and culturally relevant mathematics education?

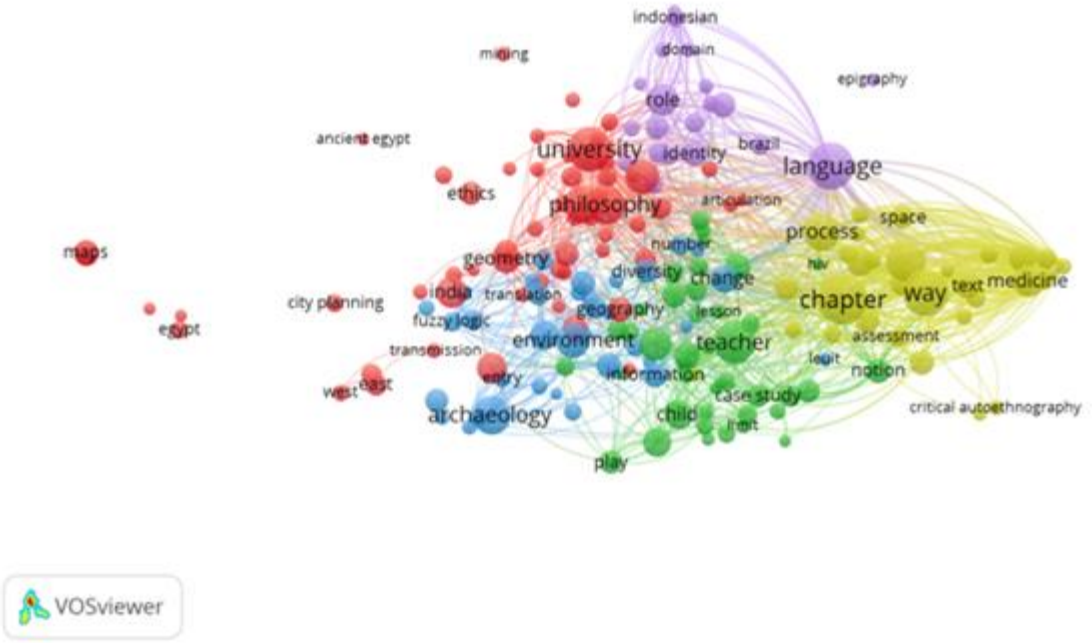


Figure 5. The terms related to the query "oral traditions as a fount of ethnomathematical knowledge" are visualized through the network map

Secondly, cluster 2 focuses on the educational and pedagogical aspects of mathematics, as evidenced terms like "mathematics educator", "pedagogy", and "school mathematics". The emphasis on "cultural diversity" and "social practice" suggests a recognition of the sociocultural context in which mathematics learning takes place. This cluster highlights the importance of understanding how mathematical knowledge is taught, learned, and applied in different cultural settings. The green color assigned to this cluster in Figure 5 may symbolize growth, development, and the nurturing of mathematical understanding. According to the second cluster, the future work could be benefited by address these following research questions: (a) what are the pedagogical challenges and opportunities in incorporating ethnomathematical perspectives into mainstream mathematics education; (b) how can teacher education programs be redesigned to equip educators with the knowledge and skills necessary to teach ethnomathematics effectively; (c) what is the role of language and cultural mediation in facilitating the learning of mathematics through oral traditions; (d) how can ethnomathematical research contribute to the development of culturally responsive assessment tools and practices; and (e) what are the implications of ethnomathematics for reconceptualizing mathematical literacy and numeracy?

Thirdly, cluster 3 is characterized by terms related to culture, geography, and indigenous knowledge. Terms like "ethnic group", "indigenous person", and "local community" emphasize the importance of cultural context in shaping mathematical practices. The inclusion of "East Asia", "Southeast Asia", and "South America" highlights

the global scope of ethnomathematical research. This cluster, represented by blue in Figure 5, suggests the vast and diverse landscape of cultural influences on mathematical thought. Based on the third cluster, future study can consider these following research questions to be examined: (a) how do specific cultural and historical contexts shape the development of ethnomathematical knowledge systems; (b) what are the methodologies and ethical considerations for conducting ethnomathematical research in indigenous communities; (c) how can comparative analysis of ethnomathematical practices across different cultures contribute to a broader understanding of human cognition and mathematical thought; (d) what is the role of globalization and intercultural exchange in the transformation of traditional mathematical practices; and (e) how can ethnomathematical research inform policies and practices aimed at preserving and revitalizing indigenous cultures and languages?

Table 4. The five clusters of term occurrence regarding the query of "oral traditions as a fount of ethnomathematical knowledge" extracted from examined publications (2014 to 2024)

Cluster	Items	Cluster Color of Figure 5	Term (10 notable samples)
1	60	Red	calendars, city planning, curricula, geometry, mapmaking, maps, mathematician, musical rhythm, scientific knowledge, transmission
2	43	Green	cultural diversity, mathematical idea, mathematical practice, mathematics educator, mathematics teacher, numeracy, pedagogy, school mathematics, social practice
3	36	Blue	artefact, East Asia, ethnic group, ethnoarchaeology, folklore, fuzzy logic, indigenous person, local community, Southeast Asia, South America
4	31	Yellow	assessment, conception, content, critical autoethnography, practitioner, text, structure, tradition, voice, way
5	20	Purple	academic, Brazil, epigraphy, Indonesian, Indonesian language, language, preservation, stem education, stem subject, transformation

Fourthly, cluster 4 primarily consists of terms associated with research methodology and theoretical underpinnings. Terms such as "assessment", "conception", and "structure" point to the analytical and conceptual frameworks employed in ethnomathematical studies. The inclusion of "critical autoethnography" and "voice" suggests a reflexive and participatory approach to research. The yellow color assigned to this cluster might symbolize the illuminating nature of research in uncovering the complexities of ethnomathematics. According to the fourth cluster, one might be interested in conducting future work by exploring these following research questions: (a) what methodological approaches are most appropriate for investigating the relationship between oral traditions and mathematical knowledge; (b) how can researchers balance the need for rigorous quantitative analysis with the interpretative demands of qualitative research in ethnomathematics; (c) what are the

theoretical frameworks that can best support the exploration of the embodied and situated nature of mathematical learning in cultural contexts; (d) how can researchers address issues of power and representation in ethnomathematical research to ensure ethical and equitable outcomes; and (e) what is the potential for interdisciplinary collaboration to advance the field of ethnomathematics?

Lastly, cluster 5 focuses on language, cultural preservation, and global education initiatives. Terms like "Indonesian language", "preservation", and "STEM education" reflect the interdisciplinary nature of the field. The inclusion of "Brazil" and "epigraphy" suggests a historical and cross-cultural perspective. This cluster, represented by purple, may symbolize the rich tapestry of languages and cultures contributing to ethnomathematics. By considering the characteristic of fifth cluster, the future work could be profited by analyzing these following research questions: (a) how do indigenous languages encode mathematical concepts and knowledge, and what are the implications for language revitalization efforts; (b) what is the role of ethnomathematical research in promoting global citizenship and intercultural understanding; (c) how can the preservation of oral traditions contribute to the development of sustainable and equitable societies; (d) what are the challenges and opportunities for integrating ethnomathematical perspectives into STEM education on a global scale; and (e) how can digital technologies be used to document, preserve, and disseminate ethnomathematical knowledge?

3.2. Discussion

In line with Rosa and Orey (2013) and Wagner and Borden (2015), ethnomathematics, a theoretical framework that has gained significant traction in recent decades, provides the epistemological underpinning for this study. This theoretical lens posits that mathematical concepts are culturally embedded, shaped by specific socio-historical contexts, and manifested in diverse cultural practices (see Figure 6). By examining the intersection of mathematics and culture, ethnomathematics challenges the view of mathematics as a monolithic, universal discipline (Wagner & Borden, 2012). Instead, it underscores the plurality of mathematical thought systems and practices across different societies (Jorgensen & Wagner, 2013). Central to ethnomathematics is the recognition that indigenous knowledge systems, often orally transmitted, encapsulate sophisticated mathematical reasoning. Oral traditions, as vehicles for preserving and transmitting cultural heritage, are repositories of ethnomathematical knowledge (Meaney, Fyhn, et al., 2022). They offer a rich tapestry of numerical systems, geometric patterns, and problem-solving strategies that have evolved over centuries. By delving into these oral narratives, researchers can uncover hidden mathematical structures and processes that have been shaped by the unique cultural and ecological contexts of specific communities.

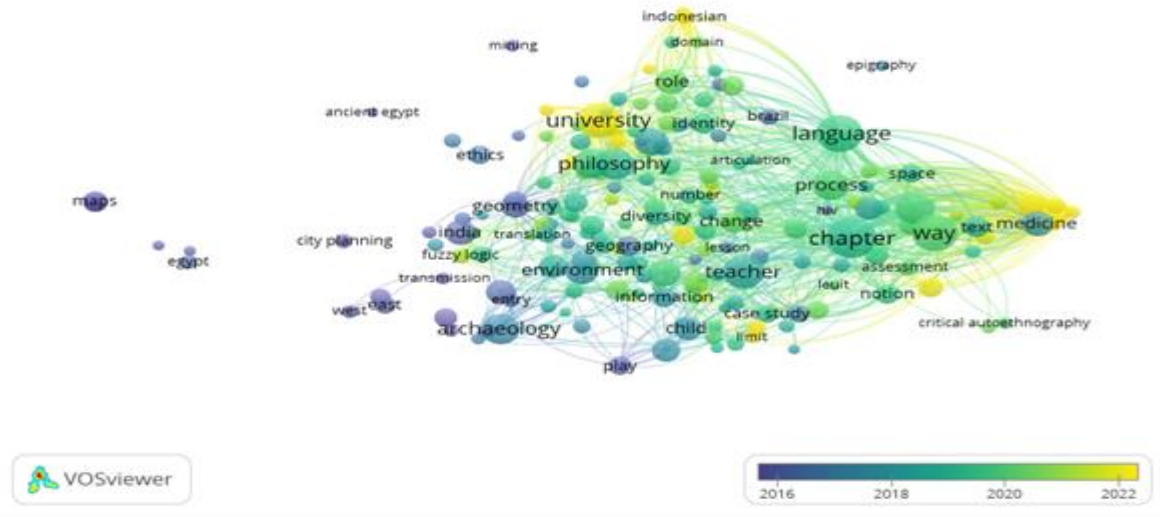


Figure 6. Overlay visualization is utilized to represent the query-associated terms graphically according to "oral traditions as a fount of ethnomathematical knowledge"

Moreover, ethnomathematics emphasizes the importance of language in constructing mathematical meaning. Through the analysis of linguistic patterns and metaphors embedded in oral traditions, researchers can explore how cultural values, beliefs, and worldviews are intertwined with mathematical concepts (Tatsis et al., 2018). This linguistic dimension of ethnomathematics is crucial for understanding how oral traditions serve as dynamic systems for generating, transferring, and transforming mathematical knowledge across generations (Wagner, 2009). For example, a prime example of ethnomathematics in action can be found in the intricate calendars developed by indigenous cultures worldwide. These calendars often incorporate astronomical observations, ecological knowledge, and cultural traditions to tract the passage of time, predict seasonal changes, and regulate social and religious activities. The notable example is the Maya civilization developed a highly sophisticated calendar system based on the solar year, lunar cycles, and the movements of the planet Venus. The Maya calendar incorporated complex mathematical calculations, including the use of base-20 and base-360 number systems.

In this respect, oral traditions offer a rich and multifaceted source of ethnomathematical knowledge. As repositories of cultural heritage, these traditions encapsulate centuries of collective wisdom, including sophisticated mathematical ideas and practices (Meaney et al., 2016). By analyzing oral narratives, researchers can uncover hidden mathematical structures, algorithms, and problem-solving strategies that have been developed and communicated throughout generations. These embedded mathematical concepts often reflect the unique cultural, ecological, and historical contexts of specific communities, providing valuable insights into the diverse ways in which humans have engaged with mathematical ideas (Meaney, Trinick, et al., 2022). Oral traditions also provide a unique lens for exploring the relationship between language, culture, and mathematics. Linguistic structures, such as metaphors, similes, and counting systems, often embed implicit mathematical reasoning. By examining the linguistic features of oral narratives, researchers can gain a deeper understanding of how mathematical concepts are conceptualized, encoded, and transferred within a particular cultural context. This linguistic perspective offers

valuable insights into the cognitive processes underlying mathematical thought and how cultural values and beliefs shape mathematical practices.

On the other hand, anthropolinguistics, as a discipline that investigates the relationship between language, culture, and cognition, provides a critical theoretical framework for examining oral traditions as a conduit for ethnomathematical knowledge. Aligned with Parra and Trinick (2018), at the core of this perspective is the understanding that language is not merely a system of symbols but a complex tool for shaping thought, worldviews, and cultural practices. Oral traditions, as primarily linguistic artifacts, are thus repositories of cultural knowledge, including mathematical concepts and practices (Trinick & May, 2013). For instance, the *Serat Wulangreh* is a renowned Javanese epic poem that offers mathematical concepts embedded within its cultural and philosophical context. The poem, compose by King Susuhunan Pakubuwono IV of Surakarta in the 19th century, delves into several aspects of life, including ethics, spirituality, and knowledge. One notable example of mathematical thinking is the *Serat Wulangreh* is the concept of *rerat*, which translates roughly to "pattern" or "order". The poem frequently emphasizes the importance of rerat in all aspects of life, from natural words to human society. This concept can be interpreted as a mathematical principle of regularity, symmetry, and harmony. The poem suggests that understanding and appreciating rerat is essential for living a balanced and fulfilling life. In addition, the *Serat Wulangreh* employes mathematical metaphors to convey philosophical ideas. For instance, the concept of ngukur ("to measure") is used to describe the process of self-reflection and spiritual growth. This suggests that spiritual development is a form of measurement, where one evaluates their progress towards enrichment or perfection.

Furthermore, the analysis of the *Serat Wulangreh* provides a compelling example of the example between ethnomathematics and anthtropolinguistics. By examining the poem's use of mathematical metaphors, such as *rerat* and *ngukur*, one can discern how cultural and linguistic practices shape mathematical thought. The concept of *rerat*, signifying "pattern" or "order", reflects a culturally embedded understanding of mathematical principles like regularity, symmetri, and harmony. This resonates with ethnomathematical perspectives that emphasize the contextual and cultural nature of mathematical knowledge. Besides, the methaphorical use of *ngukur* ("to measure"), as in (a) *tan mangkono etunge kang uwis weruh* ("for those who already know, the calculation is not like that"), (b) *rina wengi mung kang den etung, duweke liyan nenggih* ("the days and nights that count belong to other people"), (c) *lamun menang lali gawe angkuh, pan kaya bopati, wewah tan ngarah-arah* ("if he wins, he forgets the land, his behavior is like a regent, he gives without calculation"), (d) *trape kaya wong dagang, ngetung tuna bathinipun, ing tyas datan pangrasa* ("he/she acts like a trader, all that counts is profit and loss, he doesn't feel it in his heart"), and (e) *padha kaya wong bebruwun, tan ngetung duga prayoga* ("like a bad person who does not take goodness and reason into account"), to describe spiritual growth highlights the interweaving of mathematical concepts with broader cultural values and philosophical ideas. This analysis underscores the crucial role of language in shaping and transmitting mathematical knowledge within specific cultureal contexts, supporting the argument that oral traditions serve as rich repositories of ethnomathematical insights. The *Serat Wulangreh* thus

exemplifies how anthropolinguistic analysis can illuminate the intricate connections between language, culture, and mathematical thinking, enriching our understanding of the diverse ways in which mathematical concepts are embodied and expressed across cultures.

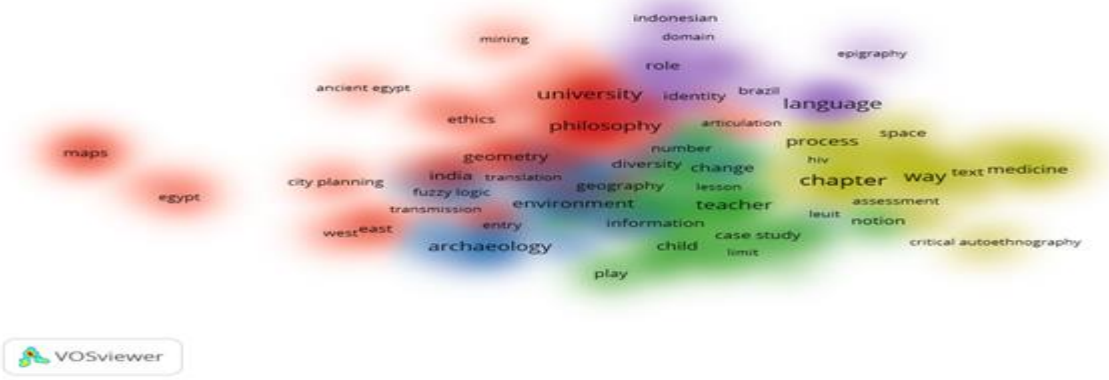


Figure 7. A density visualization is employed to illustrate the conceptual framework surrounding "oral traditions as a fount of ethnomathematical knowledge"

The intersection of language and mathematics within oral traditions is particularly fertile ground for anthropological inquiry (see Figure 7). In support of Otte (2007), linguistic structures, such as metaphors, similes, and counting systems, often embedded implicit mathematical reasoning. For instance, spatial metaphors to describe numerical quantities or geometric patterns reveal underlying culturally specific cognitive processes. By analyzing the linguistic features of oral narratives, researchers can uncover how mathematical ideas are conceptualized, encoded, and transmitted within a particular cultural context (Sabba & D'Ambrosio, 2021). Furthermore, anthropolinguistics offers insights into the dynamics of language change and cultural evolution. As oral traditions are passed down through generations, linguistic transformations occur, which may also impact embedded mathematical knowledge (Wagner et al., 2023). By studying these changes, researchers can trace the development of ethnomathematical concepts and practices (Ingram & Meaney, 2022). Additionally, anthropolinguistics can help to illuminate the role of bilingualism and multilingualism in shaping mathematical thinking. In communities where multiple languages coexist, oral traditions may offer opportunities to compare different mathematical worldviews.

To some extent, this bibliometric analysis offers insights into the evolving relationship between mathematics and culture, enriching our understanding in several key ways. Firstly, the identification of prominent research themes, such as the role of language and culture in shaping mathematical thought, highlights the increasing recognition of mathematics as s culturally embedded practice. This challenges the traditional view of mathematics as a universal and culture-free domain, emphasizing the influence of cultural contexts on mathematical meaning-making and knowledge production. By examining oral traditions, as a source of ethnomathematical knowledge, this study reveals the diverse ways in which mathematical concepts are embodied and transmitted across cultures, contributing to a more nuanced and inclusive understanding of mathematics. Furthermore, the analysis underscores the growing interest in the intersection of mathematics and language, suggesting

a shift towards recognizing the importance of linguistics and cultural diversity in mathematics education.

From a practical standpoint, this study has implications for educators and curriculum developers. By highlighting the pedagogical implications of incorporating ethnomathematics into formal education, the research encourages a more culturally responsive approach to mathematics teaching. Recognizing oral traditions as a valuable resource for ethnomathematical learning can empower educators to connect mathematical concepts with students' cultural backgrounds and lived experiences, fostering a deeper understanding and appreciation for the subject. Moreover, the identification of influential scholars and key research clusters provides a roadmap for future research and collaboration in the field of ethnomathematics. This can facilitate the development of culturally relevant pedagogical materials and strategies that promote inclusivity and equity in mathematics education. By bridging the gap between academic research and classroom practice, this study contributes to a more culturally enriched and engaging mathematical learning experience for all students.

4. CONCLUSION

This study has conducted a bibliometric analysis of the contemporary research landscape surrounding "oral traditions" and "ethnomathematical knowledge". By examining a corpus of 713 publications extracted from the Dimensions database, we have identified key research themes, authors, publishers, and keywords amongst other bibliographic metrices. As the main conclusion, the present study revealed a growing interest in the field, with focus on (a) educational context, (b) cultural studies, and (c) the intersection of mathematics and language. This analysis also identified key research themes, such as (a) the role of language and culture in shaping mathematical thought, (b) the development of ethnomathematical practices, and (c) the pedagogical implications of incorporating ethnomathematics into formal education. Based on the terms distribution analysis, there is a result of 5 distinctive clusters related to the query emerged within the research objective.

Moreover, the findings of this study have theoretical and empirical implications. From a theoretical perspective, the analysis confirms the importance of ethnomathematics as a framework for understanding the cultural embeddedness of mathematical knowledge. Empirically, the analysis identifies key research themes that are shaping the field, such as the role of language and culture in shaping mathematical thought, the development of ethnomathematical practices, and the pedagogical implications of incorporating ethnomathematics into formal education.

Future research on oral traditions and ethnomathematics could explore several avenues. One promising direction is to conduct in-depth case studies of specific oral traditions to uncover the hidden mathematical structures and practices embedded within them. Additionally, comparative studies across different cultural contexts could provide valuable insights into the diversity and universality of mathematical thought. Furthermore, research on the pedagogical implications of ethnomathematics could contribute to the development of more culturally responsive and inclusive mathematics education.

Declarations

Author Contribution : ASN: Conceptualization, Data Curation, Formal analysis, Methodology, Validation and Supervision, Writing - Review & Editing; DSN: Conceptualization, Writing - Original Draft, Investigation, Editing and Visualization, Project Administration, Validation and Supervision.

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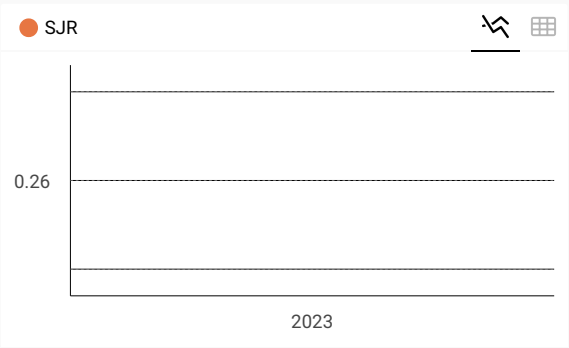

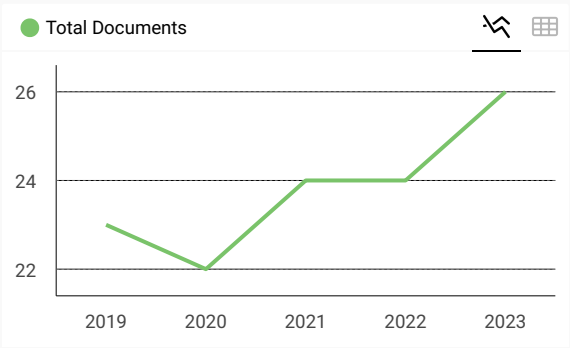

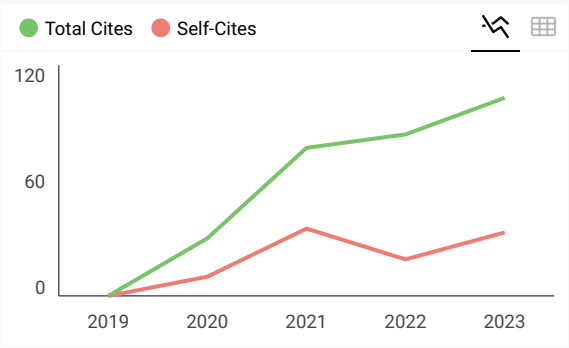

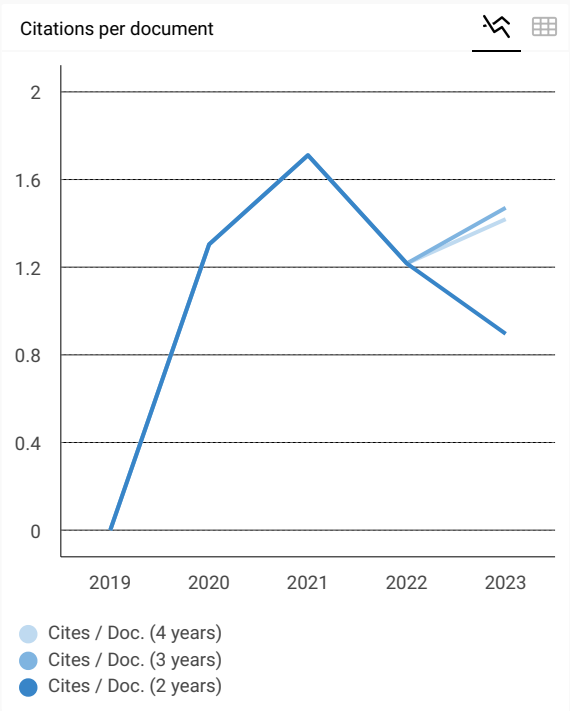

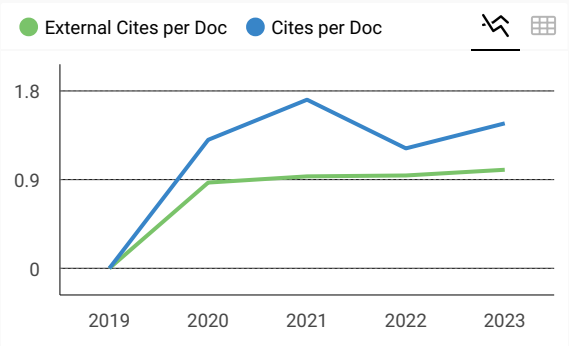

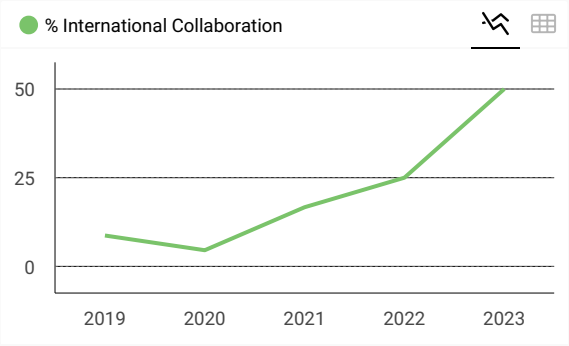

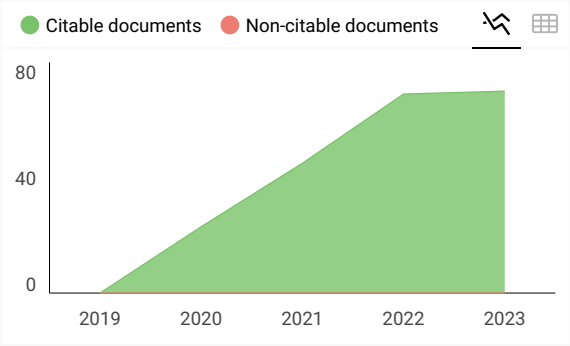

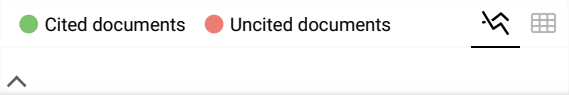

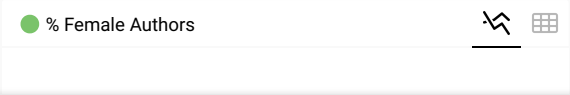

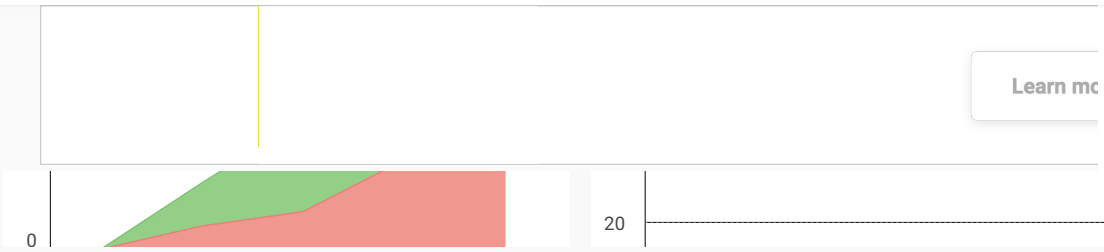

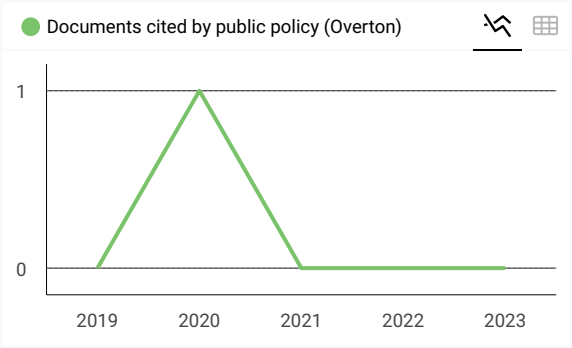

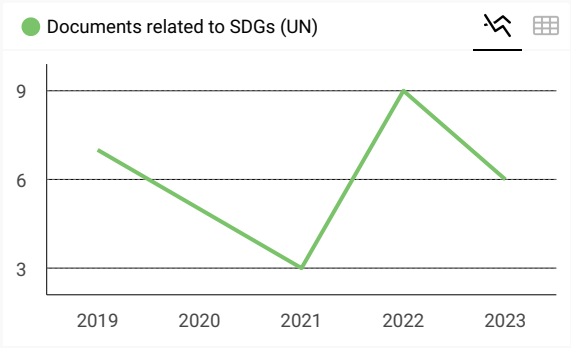

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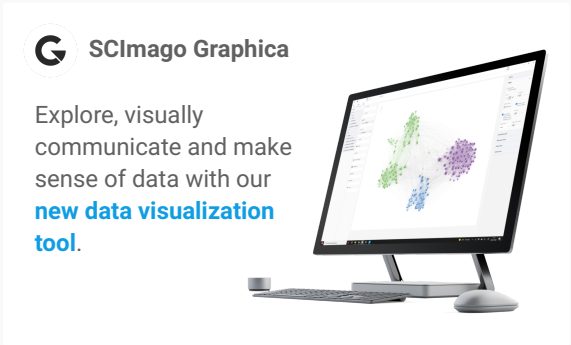

Metrics based on Scopus® data as of March 2024