Learning Mathematics Using an Ethnomathematics Approach: A Systematic Literature Review

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The study of ethnomathematics has grown significantly over the decades, especially for teaching academic mathematics in schools. However, only a small number of studies comprehensively examine research trends in the use of ethnomathematics for mathematics learning. Thus, research trends for the years 2018 to 2022 were thoroughly analyzed through systematic literature reviews referring to the standards of Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA). This review found 24 journal articles from the top indexing databases called Scopus and Eric. The finding of the SLR indicate that two types of ethnomathematics research are found if categorized based on the research data source. The 'cultural forms' used in ethnomathematics research into three categories: ideas, activities, and artifacts. Indonesian researchers (n=19) dominated the collected studies as systematic review only included publications published in English. The categorization of the studies are ethnomathematics (pure) and ethno-modelling, and the most studied mathematical topics are geometry (n=11), followed by algebra (n=5), numbers (3), sets (n=2), and arithmetic (n=1).

Keyword: ethnomathematics approach, ethno-modeling, math learning, systematic review

INTRODUCTION

Often mathematics is taught through formal processes with normative and dogmatic principles far from society's socio-cultural realities. As a result, learning mathematics feels meaningless because students cannot fully understand mathematics, so students do not understand how to implement mathematical knowledge to solve problems in everyday life. At least, that describes the reasons many researchers used to study ethnomathematics for mathematics learning. They agreed that the ethnomathematics approach is an innovation in mathematics learning that can be used to teach mathematics in formal classes (Machaba & Dhlamini, 2021). Applying ethnomathematics as a pedagogical act in mathematics learning restores a sense of pleasure or involvement and can increase creativity in doing mathematics (D'Ambrósio, 2005; Prahmana & D'Ambrosio, 2020; Risdiyanti & Prahmana, 2021). Teaching mathematics by considering that mathematics is an expression of the development of human culture and thought is a relevant reason for teaching mathematics based on ethnomathematics (D'Ambrósio, 2005; D'Ambrosio & D'Ambrosio, 2013). Thus, mathematics learning needs to be started by using the real context of socio-cultural and the reality around students. Student needs are not just learning external values and rigid academic mathematical knowledge (Prahmana, 2022). For this consideration, mathematics education must contextualize mathematics with the student's cultural environment. In essence, science arises from the needs and expectations of community members in a certain culture to respond to the environment and answer various problems faced in their lives.

D'Ambrosio (1999) developed a trivium curriculum, which consists of *literacy*, *matheracy*, and *technocracy*, allowing it to be developed in school activities. This was the forerunner of the study of ethnomathematics as an approach to learning mathematics. In the perspective of ethnomathematics, *literacy* is defined as the ability that students have to process, write, represent, calculate and use a variety of media; *matheracy* is defined as the ability that students have to interpret and analyze signs and codes to propose a model to find solutions to everyday problems; and *technocracy* is interpreted as the ability that students have to use and combine various technological instruments that help students in their daily activities to assess the reasonableness of their results and contextualization (D'Ambrosio, 1999; D'Ambrosio & D'Ambrosio, 2013). The meaning of trivium curriculum in mathematics learning does not have a special emphasis on culture. This is in line with the opinion of Gerdes (1994) who defines ethnomathematics as "the mathematics implicit in each practice."

Ethnomathematics as an approach to mathematics learning aims to create meaningful learning (Sharma & Orey, 2017), but has the potential to create a different learning atmosphere in each region and allow social inequality due to these cultural differences. There is no guarantee that each group will accept another culture from outside. Students' incomprehension of the cultural context used allows students to have more difficulty learning mathematics or can even undermine students' understanding of mathematics. As Katz (1994) argues, "ethnomathematics can contribute to the student's understanding of traditional societies.

Nevertheless, this does not mean that these achievements should undermine or replace ‘mainstream’/ ‘academic’ mathematics.” The introduction of ideas of ethnomathematics in schools can serve as an exclusion factor because students from “dominant cultures” continue to study academic mathematics, allowing them to compete in an increasingly mathematical world. However, students from other cultures will only learn local and basic knowledge that hardly contributes to their emancipation (Pais, 2011). Researchers believe that paying attention to students’ shared experiences can help create meaningful learning, even if mathematics can be taught effectively and meaningfully without associating it with culture or individual students. Because if mathematics is considered meaningless, incomprehensible, and not a popular subject for most students, then the fault may lie with the educator.

This systematic literature review (SLR) study analyzes whether ethnomathematics can be categorized as a learning approach in mathematics that meets elements of truth (ontological, epistemological, and axiological). Many SLR studies on ethnomathematics have been carried out, but they are limited to the exploration of ethnomathematics in a particular culture (Amanda & Putra, 2022; Deswita & Muslim, 2021; Nova & Putra, 2022; Nurfauziah & Putra, 2022; Okti Yolanda & Putra, 2022; Santoso & Kurino, 2021; Sopamena, Sehuwaky, Kaliky, Juhaevah, & Litiloly, 2022; Turmuzi, Sudiarta, & Suharta, 2022) without seeing its urgency in cognitive and pedagogical studies in mathematics learning. Therefore, by taking advantage of this opportunity, this SLR study can identify what cultures have been studied and clarify what kind of ‘cultural’ boundaries can be used as context in implementing the ethnomathematics approach. This study has the potential to add to the conversation by offering a complete picture of ethnomathematics in mathematics teaching and learning.

RESEARCH METHODOLOGY

Research Questions

1. Who is the source of ethnomathematics research data in mathematics learning: students, teachers, figures, or documents?
2. What cultural object is used: ideas, activities, or artifact?
3. Where (country) research is carried out?
4. What studies are used: ethnomathematics or ethno-modeling?
5. Are the results of the study used for mathematics learning content: yes (what material) or not?

Research Design

This Systematic Literature Review (SLR) study draws on the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) standards to offer a comprehensive overview of the justification of ethnomathematics approaches in mathematics learning, answering a defined research question by collecting and summarizing all empirical evidence that fits pre-specified eligibility criteria. SLR is a technique for acquiring pertinent information on a subject that satisfies predetermined eligibility requirements (Mengist, Soromessa, & Legese, 2020). PRISMA creates a uniform, peer-reviewed technique that uses checklists of best practices to help ensure the quality and reproducibility of the revision process (Conde et al., 2020). Identification, screening, eligibility, and inclusion are the foundational elements of PRISMA.

Identification, a search was performed on the Scopus and ERIC database. As a result, 208 journal articles (145 articles from Scopus and 63 from ERIC) were found based on Title-Abstract-Keywords search: “Ethnomathematics” OR “Ethno-modeling” AND “Mathematics Education” OR “Mathematics Learning” OR “Mathematics Teaching.”

Screening the items first underwent a manual screening (title and abstract). Following the screening phase, 208 papers met the study’s criteria, while 5 articles were identified as duplicates. Additionally, there are just 203 articles remaining. Next, the inclusion criteria were put into practice, leaving 35 articles.

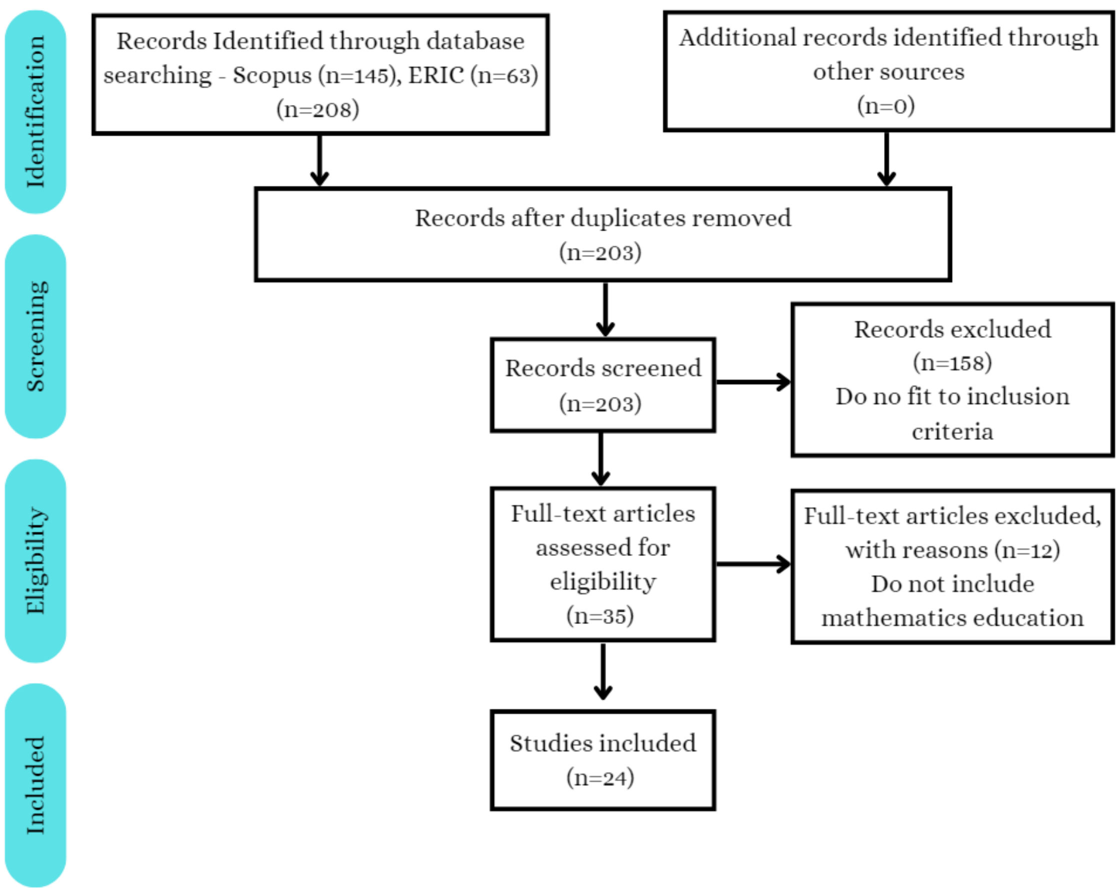
Eligibility, at this point, 11 articles have been rejected because they do not fully explain ethnomathematics in mathematics education or do not clearly explain and review the findings data in the study findings section. As a result, 24 articles were selected for publication in the final stage of the review process (see Figure 1).

Inclusion and exclusion criteria, only articles that match the following inclusion requirements are selected:

1. Published in scientific journals between 2018-2022.
2. Discusses ethnomathematics in mathematics learning.
3. Registered in Scopus or ERIC databases (for indexing and citation quality).
4. English language.

To determine the appropriately targeted articles, we set the following exclusion criteria for different categories of documents: conference proceedings, books, book reviews, magazines, short surveys, short communications, correspondences, newsletters, discussions, product reviews, editorials, publisher's notes, and erratum.

FIGURE 1
PRISMA FLOW DIAGRAM



REVIEW RESULT

All 24 papers were analyzed to gather the information that helped us with our research topic and then categorized into five main categories.

- Data Source
- Cultural Forms
- Country of Research
- Studies used
- Usefulness of research results for mathematics learning

Table 1 summarizes and compares selected papers, which include inclusion criteria.

TABLE 1
THE CONTENT ANALYSIS ON REVIEWED ARTICLES

Author/Year	RQ1	RQ2	RQ3	RQ4	RQ5
Supriadi, 2022	S	Activity	IND	Ethno-modeling	Number
Chahine, 2020	S	Activity	ZAF	Ethno-modeling	Number
Prahmana & Istiandaru, 2021	D	Idea	IND	Ethno-modeling	Set
Johnson et al., 2022	D	Activity	ARE	Ethno-modeling	Algebra & Geometry
Mirza et al., 2022	S	Artifact	IND	Ethno-modeling	Geometry
Utami et al., 2019	D, CF	Idea	IND	Ethnomathematics	No
Sari et al., 2022	D	Artifact	IND	Ethno-modeling	Geometry
Laurens et al., 2020	CF	Activity	IND	Ethnomathematics	No
Supiyati et al., 2019	CF	Artifact	IND	Ethnomathematics	No
Payadnya et al., 2021	S	Artifact	IND	Ethno-modeling	Geometry
Prahmana et al., 2021	CF	Idea	IND	Ethno-modeling	Algebra
Pathuddin et al., 2021	CF	Activity	IND	Ethno-modeling	Geometry
Fauzi et al., 2022	CF	Artifact	IND	Ethno-modeling	Geometry
Nursyahidah & Albab, 2021	S	Activity	IND	Ethno-modeling	Geometry
Busrah & Pathuddin, 2021	CF	Activity	IND	Ethno-modeling	Geometry
Sunzuma et al., 2021	T, S	Activity	ZWE	Ethno-modeling	Arithmetic
Prahmana & D'Ambrosio, 2020	CF	Activity	IND	Ethno-modeling	Geometry
Acharya et al., 2021	T	Activity	NPL	Ethnomathematics	No
Gök, 2020	CF	Activity	TUR	Ethno-modeling	Algebra
Umbara et al., 2021	CF	Activity	IND	Ethno-modeling	Algebra & Set
Nursyahidah et al., 2018	S	Activity	IND	Ethno-modeling	Algebra
Hariastuti et al., 2020	S	Artifact	IND	Ethno-modeling	Number
Nur et al., 2020	S	Activity	IND	Ethno-modeling	Geometry
Nugraha et al., 2020	S	Activity	IND	Ethno-modeling	Geometry

Note. RQ: Research question; S: Student; T: Teacher; D: Document; CF: Culture figure; IND: Indonesia; ZAF: South Africa; ARE: United Arab Emirates; ZWE: Zimbabwe; NPL: Nepal; TUR: Turkey

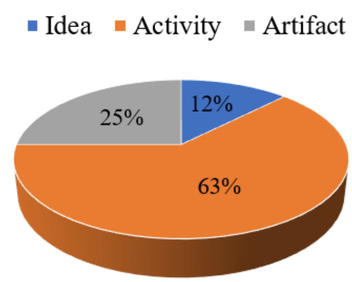
Data Sources

The first research question relates to the research data source (student, teacher, figure, or document). Two types of ethnomathematics research are found if categorized based on the research data source. (1) ethnomathematics research conducted to uncover mathematical concepts in a particular cultural community and identify its modeling potential as an object for mathematics learning in schools, (2) research aimed at testing or analyzing the use of ethnomathematics as an approach to mathematics learning in schools. The distribution of ethnomathematics research based on data sources has the same portion, namely each (n=12). The first type, the source of the data is obtained from figures or documents (Busrah & Pathuddin, 2021; Fauzi et al., 2022; Gök, 2020; Laurens et al., 2020; Pathuddin et al., 2021; Prahmana et al., n.d.; Prahmana & D'Ambrosio, 2020; Prahmana & Istiandaru, 2021; Sari et al., 2022; Supiyati et al., n.d.; Umbara et al., 2021; Utami et al., 2019). The second type, the source of the data is obtained from teachers or students as content for learning mathematics in schools (Acharya et al., 2021; Chahine, 2020; Hariastuti et al., 2020; Johnson et al., 2022; Mirza et al., 2022; Nugraha et al., 2020; Nur et al., 2020; Nursyahidah & Albab, 2021; Nursyahidah et al., 2018; Payadnya et al., 2021; Sunzuma et al., 2021; Supriadi, 2022).

Cultural Forms

Regarding the second research question, we categorized the 'cultural forms' used in ethnomathematics research into three categories: ideas, activities, and artifacts. Ideas are cultures that take the form of ideas, collections of values, norms, and rules, which are abstract in nature. Because it is abstract, of course, this idea cannot be felt or touched, but the existence of this cultural form can be expressed in writing. The cultural results in the form of this idea are commonly known as books, written works, and others. Activity is a form of culture through actions patterned from humans in the community environment. This form is often also referred to as a social system consisting of human activities that interact, communicate, and associate with each other according to certain patterns in society's rules. Artifacts or works are a form of physical culture in the form of the results of the activities and works of all humans in society in the form of objects that can be felt, can be seen, or can also be documented.

FIGURE 2
DISTRIBUTION OF PUBLISHED ARTICLES BY CULTURE

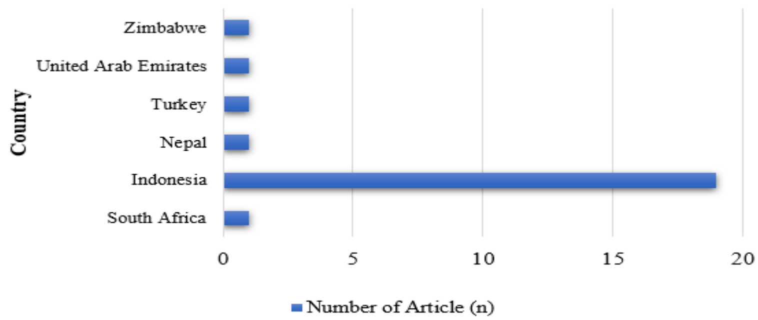


Based on Figure 2, ethnomathematics research was mostly done on activity (n=15), then six studies on artifacts, and the rest (n=3) on ideas. Activity research in the form of games (Chahine, 2020; Gök, 2020; Johnson et al., 2022; Nugraha et al., 2020; Supriadi, 2022), the process of making regional specialties (Busrah & Pathuddin, 2021; Nursyahidah & Albab, 2021; H. Pathuddin & Nawawi, 2021), the process of making crafts (Laurens et al., 2020; Prahmana & D'Ambrosio, 2020), counting good days (Umbara et al., 2021), visits a place (Sunzuma et al., 2021), cultural rituals (Acharya et al., 2021; Nur et al., 2020), and daily activities (Nursyahidah et al., 2018). Research on artifacts in the form of traditional houses (L. Fauzi et al., 2022; Hariastuti et al., 2020; Mirza et al., 2022; Sari et al., 2022; Supiyati et al., 2019) and ritual tools (Payadnya et al., 2021). The cultural form of ideas that are the object of research is in the form of folklore (Prahmana & Istiandaru, 2021), Javanese *primbon* (Utami et al., 2019), and the *pranatamangsa* system and birth-death ceremonies of the people of Yogyakarta (Prahmana et al., 2021).

Country of Study

Figure 3 categorizes selected studies according to the country they were conducted in. Whereas our systematic review only included publications published in English, the research was conducted in various cultural contexts worldwide. It can be shown that Indonesian researchers (n=19) dominated the collected studies. Figure 3 categorizes selected studies according to the country they were conducted in. Whereas our systematic review only included publications published in English, the research was conducted in various cultural contexts worldwide. It can be shown that Indonesian researchers (n=19) dominated the collected studies (Busrah & Pathuddin, 2021; Fauzi et al., 2022; Hariastuti et al., 2020; Laurens et al., 2020; Mirza et al., 2022; Nugraha et al., 2020; Nur et al., 2020; Nursyahidah & Albab, 2021; Pathuddin et al., 2021; Payadnya et al., n.d.; Prahmana & D'Ambrosio, 2020; Prahmana & Istiandaru, 2021; Sari et al., 2022; Supiyati et al., 2019; Supriadi, 2022; Umbara et al., 2021; Utami et al., 2019), and others one study each in the following countries: Zimbabwe (Sunzuma et al., 2021), United Arab Emirate (Johnson et al., 2022), Turkey (Gök, 2020), Nepal (Acharya et al., 2021), South Africa (Chahine, 2020).

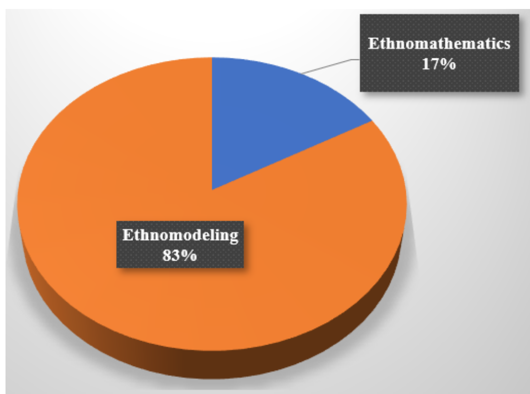
FIGURE 3
DISTRIBUTION OF RESEARCH STUDIES BY COUNTRY



Studies Used

In this third subsection, we categorize the studies in two categories: ethnomathematics (pure) and ethno-modeling (Figure 4).

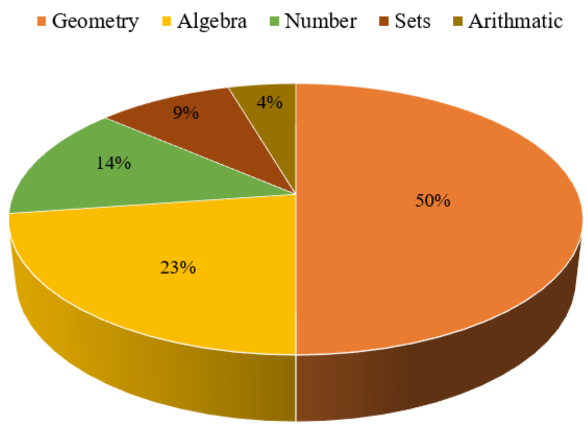
FIGURE 4
DISTRIBUTION OF RESEARCH STUDIES BY STUDY TYPES



The research leading to ethno-modeling (n=20) is in great demand by researchers (Busrah & Pathuddin, 2021; Chahine, 2020; Chen et al., 2020; Fauzi et al., 2020; Gök, 2020; Johnson et al., 2022; Mirza et al., 2022; Nugraha et al., 2020; Nur et al., 2020; Nursyahidah et al., 2018; Nursyahidah & Albab, 2021; Pathuddin & Nawawi, 2021; Payadnya et al., 2021; Prahmana et al., 2021; Prahmana & D'Ambrosio, 2020; Prahmana & Istiandaru, 2021; Sari et al., 2022; Sunzuma et al., 2021; Supriadi, 2022; Umbara et al., 2021). Only 4 studies (Acharya et al., 2021; Laurens et al., 2020; Supiyati et al., 2019; Utami et al., 2019) purely examine ethnomathematics.

The Usefulness of Research Results for Mathematics Learning

FIGURE 5
DISTRIBUTION OF MATHEMATICS TOPICS STUDIED



The fifth subsection identifies the use of cultural content that has been studied for mathematics learning. Many researchers (n=20) justify that the research results found can be implemented as mathematics learning content (Busrah & Pathuddin, 2021; Chahine, 2020; Fauzi et al., 2020; Gök, 2020; Hariastuti et al., 2020; Johnson et al., 2022; Mirza et al., 2022; Nugraha et al., 2020; Nur et al., 2020; Nursyahidah et al., 2018; Nursyahidah & Albab, 2021; Pathuddin & Nawawi, 2021; Payadnya et al., 2021; Prahmana et al., 2021; Prahmana & D'Ambrosio, 2020; Prahmana & Istiandaru, 2021; Sari et al., 2022; Sunzuma et al., 2021; Supriadi, 2022; Umbara et al., 2021). The remaining four researchers (Acharya et al., 2021; Laurens et al., 2020; Supiyati et al., 2019; Utami et al., 2019) do not justify that the mathematical models revealed can be used for learning. The most studied mathematical topics are geometry (n=11), followed by algebra (n=5), numbers (3), sets (n=2), and arithmetic (n=1).

DISCUSSION

To encourage the creation of new mathematical knowledge, D'Ambrosio (1985) initiated ethnomathematics, which returned mathematical knowledge to be discovered from the cultural roots of different societies. He values dialogue and dissent to revive critical and democratic reasoning in everyone who studies it, values differences and is tolerant of various variations of knowledge (D'Ambrosio, 2007). This stub has attracted many people to study ethnomathematics through various techniques and data sources. Concerning the focus of the study on research data sources, all ethnomathematics research is started by exploring information related to culture from sources outside the school. Research conducted in schools with the subject of teacher or student research is a follow-up to the results of the ethnomathematics study itself. The findings showed that 50% of ethnomathematics study results were followed up for the success of mathematics learning in schools. This indicates that ethnomathematics successfully facilitates students to learn mathematics. Prahmana (2022) argues that ethnomathematics can help teachers and students understand mathematics in the context of ideas, ways, and practices used in everyday life, ultimately encouraging the understanding of school mathematics.

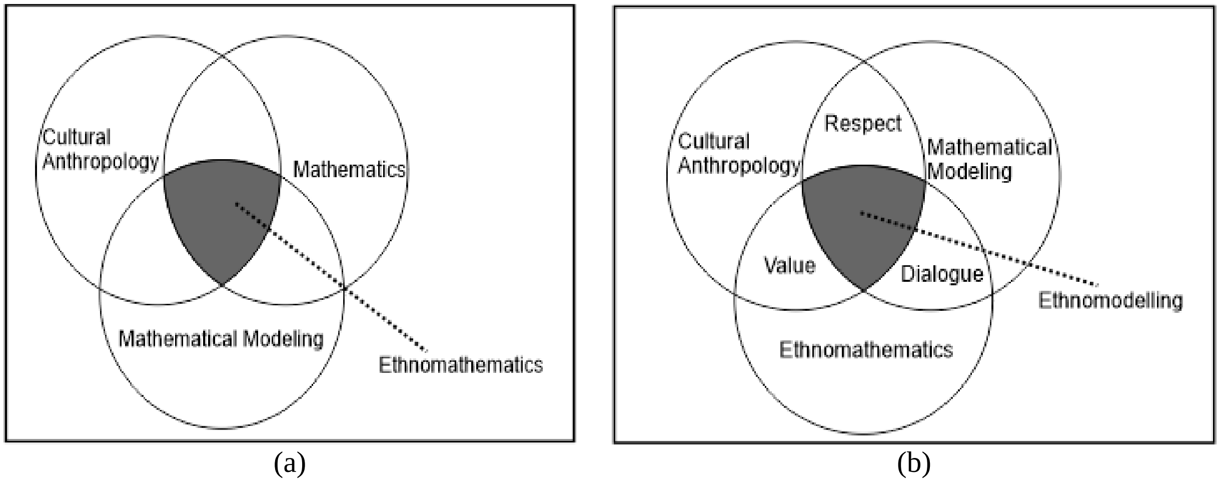
Cultural forms of 'activity' are observed to dominate ethnomathematics research. This seems natural, considering that 'ideas' and 'artifacts' are formed from human activities. Bishop (1991) considers mathematics as one of the products of a culture that develops as a result of various activities and is not limited to calculating, measuring, classifying, inferring, generalizing, and evaluating. It is part of the product of culture itself. Daily life is also impregnated with cultural knowledge and practice. Individuals always compare, using materials and tools of an intellectual nature that their culture has (D'Ambrosio, 2016). Thus, it is from there that human cultural activity creates a kind of mathematical knowledge and concepts. Each culture has developed mathematical practices that suit their needs and interests in activities. Meanwhile, cultural artifacts are understood as objects and other things created by the culture of a certain group of people and communities that it helps define their culture. Gueudet & Trouche (2009) extends the definition of artifacts by introducing the term “resource” or material to include any artifact that allows it to be implemented in the learning process. Artifacts can take the form of clothes, houses, utensils, baskets, ornaments, paintings, designs, and so on. All these artifacts provide information about the culture of their creators and the ideas associated with such objects. In terms of ideas, the ethnomathematics ideas of a group of people have generally been excluded from formal and academic mathematical discussions. Rosa & Gavarrete (2017) view that their knowledge and approach to mathematics learning are not only taken into account in the curriculum but also the mathematical ideas of the community’s cultural groups. Recognition of their way of generating and transmitting knowledge must be combined with formal mathematics in the classroom (Pradhan, 2017). Attempts to create and integrate mathematical material related to culture and that refer to the student’s own experience in the mathematics learning curriculum are very likely to apply ethnomathematics (Rosa & Gavarrete, 2017).

Next is related to the country conducting ethnomathematics research: Indonesia occupies the top position as the country conducting ethnomathematics research. Ethnomathematics, as a research genre in mathematics and mathematics education, has captivated the interest of researchers to explore mathematical concepts practiced in many groups of society. Exploring mathematical concepts in a culture becomes a breakthrough and innovation in the research base. There is so much research on ethnomathematics in Indonesia. This is natural because Indonesia is a country with ethnic diversity (Hendriyanto, Kusmayadi, & Fitriana, 2021), and many communities still use socio-cultural values in carrying out their lives.

Ethnomathematics has also led some of its users to develop innovations in techniques, methods, and explanations that lead to comprehensive understanding and action and transformation in culture. Ethno-modelling was introduced by Bassanezi (2002) with arguments about mathematical ideas, procedures and practices in culture or everyday life as interpretations of reality. This study uses ethnomathematics as a focus while also discussing the intersections of the two. At the same time, the theoretical basis of the ethnomathematics program is developing as a valid traditional study of both the philosophical, traditional and pedagogical aspects of mathematics.

Two main reasons for bringing ethnomathematics practice to schools: to uncover school mathematics as a final, permanent, absolute, and unique form of knowledge; and to describe the intellectual achievements of various civilizations, cultures, societies, professions, and genders (Johnson et al., 2022). Ethnomathematics is the intersection of cultural anthropology, mathematics, and mathematical modeling (Figure 6a), which is used to help understand and connect the diverse ideas and practices of mathematics found in a community with traditional and academic mathematics. While ethno-modeling (Figure 6b) can be considered as an area of intersection between cultural anthropology, ethnomathematics, and mathematical modeling, which can be used “as a tool towards pedagogical action from the ethnomathematics program, students have been shown to learn how to encounter and work with concrete situations and real-life problems.” (Rosa & Orey, 2013).

FIGURE 6
ETHNOMATHEMATICS (a), AND ETHNO-MODELING (b) AS AN INTERSECTION OF THREE RESEARCH FIELDS



Umbara et al. (2021) argue that ethno-modeling as a methodological approach can be said to be the development of a field of study in ethnomathematics-based research. Ethno-modeling is intended as evolution so that a group of people’s mathematical practices and activities can be studied comprehensively and no longer limited. The ethno-modeling approach will naturally erode this restrictive nature. As an approach, ethno-modeling is thought to produce studies that highlight aspects of the pedagogical approach. The resulting pedagogical approach is the result of the formulation and abstraction of the process. Ethno-modeling describes problems and questions that grow from real systems or situations into ideal configurations and mathematical versions formed through a critical analysis of the creative production of knowledge, intellectual processes, social mechanisms for institutionalizing academic knowledge, and educational transmission.

Studies focusing on the relationship between mathematics and culture allow one to reflect on different cultures and find ways to explore class challenges in classroom settings (Nkopodi & Mosimege, 2009). Through such ethno-modeling, the idea of ethnomathematics from different cultural groups can act as a tool for teaching and learning school mathematics. It is assumed that the context that students are familiar with is a powerful source for the teaching and learning of mathematics. However, connecting students’ out-of-school math ideas to teaching school math became a big problem for teachers (Palhares, 2012). Regarding incorporating cultural knowledge in classroom teaching, Paulo Freire suggests that “children’s cultural capital - the knowledge that children bring to school from their family environment and culture - should be accepted and used in schools for teaching and developing knowledge” (Pradhan, 2020). In this way, the knowledge of students outside of school rooted in the culture of their society is valued and used saiga source domains for conceptual metaphors in an appropriate way in the teaching and learning process in the classroom.

Understanding mathematics is important to everyone; they use mathematical ideas and knowledge to do their daily work. From this perspective, it can be assumed that there is a close relationship between mathematics and culture: mathematics produces culture, but it is also produced by culture (Knijnik, 2007). Knowledge and ideas of mathematics are implicitly used in cultures outside of school Prahmana & Istiandaru (2021) Argues that ethnomathematics ideas embedded in different cultural activities mediate the understanding of school mathematics. This can be elaborated based on the theory of contextual metaphors that shows the relationship between the source and target domains for effective mathematical teaching and learning. Related cultures and practices form the source domain, which students are always familiar with, aware of, and capable of defining. The target domain considered abstract and challenging is the knowledge that must be learned: mathematical knowledge. This concept justifies that incorporating ethnomathematics ideas in classroom teaching can facilitate understanding school mathematics. Students culture and daily activities regarding ethnomathematics ideas are an integral part of education in general and mathematics learning in particular (Supriadi, 2022). We believe that classrooms and other learning environments are inseparable from the cultural communities in which they thrive, and students come to school with them the values, norms, and concepts they derive from their culture and environment. This suggests that it is possible to connect school mathematics through ethnomathematics ideas and the out-of-school context of learners.

The ethnomathematics perspective allows us to test the Eurocentric discourses that make up academic mathematics and school mathematics (Nkopodi & Mosimege, 2009), to test the truth effects produced by these discourses, to talk about the problem of differences in mathematics education while considering the importance of culture and power, the relationships that build them, and challenge the dichotomy between "high" culture and "low" culture in mathematics (Knijnik, 2007). Ethnomathematics emphasizes education for social justice, where it is necessary to empower individuals by teaching them about real-world problems (Maraví Zavaleta, 2021).

Involving ethnomathematics in the school curriculum will provide a new nuance in mathematics learning, considering that each region consists of diverse tribes and cultures that have their characteristics in problem-solving (Nkopodi & Mosimege, 2009). Starting mathematics learning from surrounding cultural phenomena is important because it can reduce the gap between formal mathematics and the closest context that students can understand (Prahmana & Istiandaru, 2021), encourage spontaneous interaction among learners (Nkopodi & Mosimege, 2009), create easy and flexible mathematics learning with the mathematical concepts taught (Supriadi, 2022), showing the richness of culture that contains mathematical modeling which has the potential to be used in mathematics learning (Prahmana et al., 2021), improving students' mathematical abilities (Hartinah et al., 2019); and the findings of Johnson et al. (2022) show that combining cultural phenomena, perceptions, and preferences has a positive influence on students' math preferences and learning, even when mobile devices are not used in the teaching and learning process.

In our opinion, a researcher/teacher before using ethnomathematics as an approach to learning, it is necessary to note the following questions: whether the 'culture' used meets the criteria as a study of ethnomathematics, whether the 'culture' used is close and known by students. This means that the researcher/teacher must fully understand the theory of ethnomathematics so that it does not seem perfunctory in the use of 'culture' or mathematical disclosure. Acharya et al. (2021) support the use of 'local culture' as content in mathematics learning because its impact can motivate students to learn mathematics. They emphasize that school teachers should use cultural references to explain mathematical concepts connected with students' cultural knowledge and experience. Teachers must have local knowledge for effective student engagement in various learning actions and processes. In addition, when referring to D'Ambrosio (2018) explanation of the concept of ethnomathematics as a conceptual approach to mathematical learning, "Ethnomathematics is an approach to teaching and learning mathematics built on the student's previous knowledge, background, the role that his environment plays in terms of content and methods, and past, and present experiences of his immediate environment and his approach can be in a practical way" affirms that the 'culture' that users should be close and known by the student.

CONCLUSION

A key finding from this comprehensive assessment of the literature is that using ethnomathematics approaches to study mathematics has a positive trend toward creating meaningful learning for students. The five research concentration topics are (1) data sources: documents and cultural figures are data sources that can be used to study ethnomathematics while teachers and students as subjects of testing the results of ethnomathematics studies for mathematics learning; (2) cultural form: cultural form 'activity' dominates the study of ethnomathematics that has been carried out compared to 'ideas and artifacts'; (3) the country where the research is conducted: the diversity of tribes and cultures makes Indonesia occupy the top position in the disclosure of mathematical concepts in a particular culture; (4) studies used: research trends soared in ethno-modeling studies; and (5) the usefulness of research results for mathematics learning: the results of the study can be used for the implementation of the mathematics learning process in schools, where the topic of geometry is the most common found compared to other mathematics topics.

Ethnomathematics as an approach to learning can be justified by ontologies, epistemologically, and axiologically. Ontologically the object of ethnomathematics can be examined in its basic form and is closely related to human capture (e.g., thinking, feeling, and the use of the senses); epistemologically, ethnomathematics can be viewed based on the nature of knowledge, justification, and rationality of belief; and axiologically ethnomathematics as knowledge meets the aspects of usefulness related to the way of use and moral rules that grow in society at large. The axiological study of ethnomathematics can present the importance of exploring ethnomathematics based on mathematical rationality and cultural rationalities. In addition, this study offers new information about the tendency to apply ethnomathematics approaches in mathematics learning. Knowledge gaps in understanding patterns and trends in the research and development of mathematics learning are filled by this systematic review. In addition, a summarized review of the learning of mathematics through the ethnomathematics approach may be useful to academics and practitioners, opening up new directions for study.

Recommendation

Ethno-modeling has proven to be a methodological approach to link ethnomathematics with academic mathematics and can finally be used as content for mathematics learning in traditional schools. However, the justification that the ethnomathematics approach can be used for all school mathematics materials has not been proven. Ethnomathematics expressly limits the meaning of ‘culture’ to a ‘cultural form’ such as ideas, activities, and artifacts carried out by a particular group. The diversity of existing cultures cannot be ascertained as ethnomathematics because not all cultures contain mathematical values. Many ‘cultural forms’ still have not been revealed in the study of ethnomathematics. This is an opportunity for researchers interested in ethnomathematics studies to continue conducting ethnomathematics studies and bring them into academic mathematics through ethno-modeling.

Limitations

This study is constrained by the search terms that were employed. We only examined works found in Scopus and ERIC. Research papers on the educational uses of ethnomathematics approach may be available in other databases, such as Web of Science, Google Scholar, or Dimensions. Second, we limited the number of journal papers we included to those published between 2018 and 2022. Our review process had a significant impact on and limited the outcomes of our review. So, if any of the following—research topics, conceptual approach, selection criteria (inclusion or exclusion), and review process—were altered, our conclusions might differ from those of other reviews (identification, screening, eligibility). A more detailed and systematic review process may include elements like citation analysis, reference counting, and expert article rating. The effect analysis from the article based on reputable indexing databases might also be considered. We can do bibliometric and meta-analyses to further our thorough analysis of the literature.

REFERENCES

Acharya, B.R., Kshetree, M.P., Khanal, B., Panthi, R.K., & Belbase, S. (2021). Mathematics Educators’ Perspectives on Cultural Relevance of Basic Level Mathematics in Nepal. *Journal on Mathematics Education*, *12*, 17–48.

Amanda, N., & Putra, A. (2022). Systematic Literature Review: Etnomatematika Pada Pakaian Adat dan Atribut. *Jurnal Pendidikan Guru Matematika*, *2*(1), 96–101.

Bassanezi, R.C. (2002). Ensino-aprendizagem com modelagem matemática: Uma nova estratégia. *Editora Contexto*.

Bishop, A.J. (1991). Mathematics education in its cultural context. In M. Harris (Ed.), *Schools, mathematics and work*. London: Falmer Press. Retrieved from https://eric.ed.gov/?id=ED342614

Busrah, Z., & Pathuddin, H. (2021). Ethnomathematics: Modelling the Volume of Solid of Revolution at Buginese and Makassarese Traditional Foods. *Journal of Research and Advances in Mathematics Education*, *6*, 331–351.
Chahine, I.C. (2020). Towards african humanicity: Re-mythogolising ubuntu through reflections on the ethnomathematics of african cultures. *Critical Studies in Teaching and Learning*, *8*(2), 95–111. https://doi.org/10.14426/cristal.v8i2.251
Chen, X., Zou, D., Cheng, G., & Xie, H. (2020). Detecting latent topics and trends in educational technologies over four decades using structural topic modeling: A retrospective of all volumes of Computers & Education. *Computers and Education*, *151*, 103855. https://doi.org/10.1016/j.compedu.2020.103855
Conde, M.Á., Sedano, F.J.R., Fernández-Llamas, C., Gonçalves, J., Lima, J., & García-Peñalvo, F.J. (2020). RoboSTEAM Project Systematic Mapping: Challenge Based Learning and Robotics. *2020 IEEE Global Engineering Education Conference (EDUCON)*, pp. 214–221. https://doi.org/10.1109/EDUCON45650.2020.9125103
D'Ambrosio, U. (1985). Ethnomathematics and Its Place in the History and Pedagogy of Mathematics. *For the Learning of Mathematics*, *5*(1), 44–48. Retrieved from http://www.jstor.org/stable/40247876
D'Ambrosio, U. (1999). Literacy, Matheracy, and Technocracy: A Trivium for Today. *Mathematical Thinking and Learning*, *1*(2), 131–153. https://doi.org/10.1207/s15327833mtl0102_3
D'Ambrósio, U. (2005). Society, culture, mathematics and its teaching. *Educação e Pesquisa*, *31*(1), 99–120. Retrieved from http://www.scielo.br/j/ep/a/TgJbqssD83ytTNyxnPGBTcw/?lang=en
D'Ambrosio, U. (2007). Peace, social justice and ethnomathematics. *The Montana Mathematics Enthusiast Monograph*, (1), 25–34.
D'Ambrosio, U. (2016). *Etnomatemática-elo entre as tradições e a modernidade*. Autêntica.
D'Ambrosio, U. (2018). The program ethnomathematics: Cognitive, anthropological, historic and socio-cultural bases. *Pna*, *12*(4), 229–247. https://doi.org/10.30827/pna.v12i4.7851
D'Ambrosio, U., & D'Ambrosio, B.S. (2013). The Role of Ethnomathematics in Curricular Leadership in Mathematics Education. *Journal of Mathematics Education at Teachers College*, *4*(1), 19–25. https://doi.org/10.7916/jmetc.v4i1.767
Deswita, H., & Muslim, S. (2021). Malay Etnomathematic of Riau and Riau Islands: Systematic Literature Review. *Jurnal Pendidikan MIPA*, *22*(2), 216–225.
Fauzi, A., Widjajanti, D.B., Widodo, A., & Umar, U. (2020). Developing the Set of Mathematics Learning Materials Based on NHT Model With Peer Assessment. *Advances in Social Science, Education and Humanities Research*, *465*, 90–93. https://doi.org/10.2991/assehr.k.200827.024
Fauzi, L., Hanum, F., Jailani, J., & Jatmiko, J. (2022). Ethnomathematics: Mathematical Ideas and Educational Values on the Architecture of Sasak Traditional Residence. *International Journal of Evaluation and Research in Education*, *11*, 250–259.
Gerdes, P. (1994). Reflections on Ethnomathematics. *For the Learning of Mathematics*, *14*(2), 19–22. Retrieved from http://www.jstor.org/stable/40248110
Gök, M. (2020). Mathematical Mystery in a Cultural Game. *World Journal of Education*, *10*(6), 64. https://doi.org/10.5430/wje.v10n6p64
Gueudet, G., & Trouche, L. (2009). Towards new documentation systems for mathematics teachers? *Educational Studies in Mathematics*, *71*(3), 199–218. https://doi.org/10.1007/s10649-008-9159-8
Hariastuti, R.M., Budiarto, M.T., & Manuharawati. (2020). Incorporating Culture and Mother Tongue in Mathematics Learning: Counting Operation in Traditional Houses "Using Banyuwangi." *Malikussaleh Journal of Mathematics Learning*, *3*, 62–69.
Hartinah, S., Suherman, S., Syazali, M., Efendi, H., Junaidi, R., Jermsittiparsert, K., & Umam, R. (2019). Probing-prompting based on ethnomathematics learning model: The effect on mathematical communication skills. *Journal for the Education of Gifted Young Scientists*, *7*(4), 799–814. https://doi.org/10.17478/jegys.574275

Hendriyanto, A., Kusmayadi, T.A., & Fitriana, L. (2021). Explain Point and Line Positioning Materials Using the Ethnomathematical Approach to Enhance Students' Geometric Thinking Skills. *Psychology and Education*, *58*(5), 4199–4214.

Johnson, J.D., Smail, L., Corey, D., & Jarrah, A.M. (2022). Using Bayesian Networks to Provide Educational Implications: Mobile Learning and Ethnomathematics to Improve Sustainability in Mathematics Education. *Sustainability (Switzerland)*, *14*(10). https://doi.org/10.3390/su14105897

Katz, V.J. (1994). Ethnomathematics in the Classroom. *For the Learning of Mathematics*, *14*(2), 26–30. Retrieved from http://www.jstor.org/stable/40248112

Knijnik, G. (2007). Brazilian Peasant Mathematics, School Mathematics and Adult Education. *Adults Learning Mathematics*, *2*, 54–62.

Laurens, T., Kempa, R., & Serpara, H. (2020). The Ethnomathematics of Tutuwaru Community in the Crafts of Koli Leaf Weaving. *Online Submission*, *3*, 71–80.

Machaba, F., & Dhlamini, J. (2021). *Ethnomathematics as a Fundamental Teaching Approach BT - Mathematics Teaching and Professional Learning in sub-Sahara Africa* (K. Luneta, Ed.). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-82723-6_5

Maraví Zavaleta, L.M. (2021). Emergent curriculum in basic education for the new normality in Peru: Orientations proposed from mathematics education. *Educational Studies in Mathematics*, *108*(1–2), 291–305. https://doi.org/10.1007/s10649-021-10100-w

Mengist, W., Soromessa, T., & Legese, G. (2020). Method for conducting systematic literature review and meta-analysis for environmental science research. *MethodsX*, *7*. https://doi.org/10.1016/j.mex.2019.100777

Mirza, R., Teguh, M., & Manuharawati, M. (2022). Traditional Houses in Ethnomathematical-Thematic-Connected-Based Mathematics Learning. *International Journal of Educational Methodology*, *8*(3), 535–549. https://doi.org/10.12973/ijem.8.3.535

Nkopodi, N., & Mosimege, M. (2009). Incorporating the indigenous game of morabaraba in the learning of mathematics. *South African Journal of Education*, *29*(3), 377–392. https://doi.org/10.15700/saje.v29n3a273

Nova, I.S., & Putra, A. (2022). Eksplorasi Etnomatematika pada Cerita Rakyat. *Plusminus: Jurnal Pendidikan Matematika*, *2*(1), 67–76.

Nugraha, T., Maulana, M., & Mutiasih, P. (2020). Sundanese Ethnomathematics Context in Primary School Learning. *Elementary School Forum (Mimbar Sekolah Dasar)*, *7*, 93–105.

Nur, A.S., Waluya, S.B., Rochmad, R., & Wardono, W. (2020). Contextual Learning with Ethnomathematics in Enhancing the Problem Solving Based on Thinking Levels. *Journal of Research and Advances in Mathematics Education*, *5*, 331–344.

Nurfauziah, & Putra, A. (2022). Systematic Literature Review: Etnomatematika Pada Rumah Adat. *Jurnal Riset Pembelajaran Matematika*, *4*(1), 5–12.

Nursyahidah, F., & Albab, I.U. (2021). Learning Design on Surface Area and Volume of Cylinder Using Indonesian Ethno-Mathematics of Traditional Cookie Maker Assisted by GeoGebra. *Mathematics Teaching Research Journal*, *13*, 79–98.

Nursyahidah, F., Saputro, B.A., & Rubowo, M.R. (2018). Students Problem Solving Ability Based on Realistic Mathematics with Ethnomathematics. *Journal of Research and Advances in Mathematics Education*, *3*, 13–24.

Okti Yolanda, F., & Putra, A. (2022). Systematic Literature Review: Eksplorasi Etnomatematika Pada Motif Batik. *Prima Magistra: Jurnal Ilmiah Kependidikan, 3*(2), 188–195. https://doi.org/10.37478/jpm.v3i2.1533

Pais, A. (2011). Criticisms and contradictions of ethnomathematics. *Educational Studies in Mathematics*, *76*(2), 209–230. https://doi.org/10.1007/s10649-010-9289-7

Palhares, P. (2012). Mathematics education and ethnomathematics. a connection in need of reinforcement. *REDIMAT - Journal of Research in Mathematics Education*, *1*(1), 79–92. https://doi.org/10.4471/redimat.2012.04

Pathuddin, H., & Nawawi, M.I. (2021). Buginese Ethnomathematics: Barongko Cake. *Journal on Mathematics Education*, *12*(2), 295–312.

Pathuddin, Hikmawati, Kamariah, & Ichsan Nawawi, M. (2021). Buginese ethnomathematics: Barongko cake explorations as mathematics learning resources. *Journal on Mathematics Education*, *12*(2), 295–312. https://doi.org/10.22342/jme.12.2.12695.295-312

Payadnya, I.P.A.A., Suwija, I.K., & Wibawa, K.A. (2021). Analysis of Students' Abilities in Solving Realistic Mathematics Problems Using "what-If"-Ethnomathematics Instruments. *Mathematics Teaching-Research Journal*, *13*(4), 131–149.

Payadnya, I.P.A.A., Suwija, I.K., & Wibawa, K.A. (n.d.). Analysis of Students' Abilities in Solving Realistic Mathematics Problems Using "What-If"-Ethnomathematics Instruments. *Mathematics Teaching Research Journal*, *13*, 131–149.

Pradhan, J.B. (2017). Mathematical ideas in Chundara culture: Unfolding Nepalese teaching and learning system. In M. Rosa, L. Shirley, M.E. Gavarrete, & W.V. Alangui (Ed.), *Ethnomathematics and its diverse approaches for Mathematics Education* (pp. 125–152). Cham, Switzerland: Springer. https://doi.org/10.1007/978-3-319-59220-6

Pradhan, J.B. (2020). Cultural artefacts as a metaphor to communicate mathematical ideas. *Revemop*, *2*, 1–34.

Prahmana, R.C.I. (2022). Ethno - Realistic Mathematics Education: The promising learning approach in the city of culture. *SN Social Sciences*, pp. 1–19. https://doi.org/10.1007/s43545-022-00571-w

Prahmana, R.C.I., & D'Ambrosio, U. (2020). Learning geometry and values from patterns: Ethnomathematics on the batik patterns of yogyakarta, indonesia. *Journal on Mathematics Education*, *11*(3), 439–456. https://doi.org/10.22342/jme.11.3.12949.439-456

Prahmana, R.C.I., & Istiandaru, A. (2021). Learning sets theory using shadow puppet: A study of javanese ethnomathematics. *Mathematics*, *9*(22). https://doi.org/10.3390/math9222938

Prahmana, R.C.I., Yunianto, W., Rosa, M., & Orey, D.C. (2021). Ethnomathematics: Pranatamangsa system and the birth-death ceremonial in yogyakarta. *Journal on Mathematics Education*, *12*(1), 93–112. https://doi.org/10.22342/JME.12.1.11745.93-112

Prahmana, R.C.I., Yunianto, W., Rosa, M., & Orey, D.C. (n.d.). Ethnomathematics: "Pranatamangsa" System and the Birth-Death Ceremonial in Yogyakarta. *Journal on Mathematics Education*, *12*, 93–112.

Risdiyanti, I., & Prahmana, R.C.I. (2021). Designing Learning Trajectory of Set Through the Indonesian Shadow Puppets and Mahabharata Stories. *Infinity Journal*, *10*(2), 331. https://doi.org/10.22460/infinity.v10i2.p331-348

Rosa, M., & Gavarrete, M.E. (2017). *An Ethnomathematics Overview: An Introduction BT - Ethnomathematics and its Diverse Approaches for Mathematics Education.* In M. Rosa, L. Shirley, M.E. Gavarrete, & W.V Alangui (Eds.). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-59220-6_1

Rosa, M., & Orey, D.C. (2013). Ethnomodeling as a Research Theoretical Framework on Ethnomathematics and Mathematical Modeling. *Journal of Urban Mathematics Education*, *6*, 62–80.

Santoso, E., & Kurino, Y.D. (2021). Systematic Literatur Review : Ethnomathematic dalam Pembelajaran Matematika. *Jurnal Theorems (The Original Reasearch of Mathematics)*, *6*(1), 77–84.

Sari, A.K., Budiarto, M.T., & Ekawati, R. (2022). Ethnomathematics Study: Cultural Values and Geometric Concepts in the Traditional "tanean-lanjang" House in Madura - Indonesia. *Journal of Research and Advances in Mathematics Education*, *7*, 46–54.

Sharma, T., & Orey, D.C. (2017). *Meaningful Mathematics Through the Use of Cultural Artifacts BT - Ethnomathematics and its Diverse Approaches for Mathematics Education.* In M. Rosa, L. Shirley, M.E. Gavarrete, & W.V Alangui (Eds.). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-59220-6_7

Sopamena, P., Sehuwaky, N., Kaliky, S., Juhaevah, F., & Litiloly, H. (2022). A Systematic Review of the Ethnomamatics Characteristics in Indonesian Culture. *Jurnal Pendidikan MIPA*, *23*(3), 1195–1204. https://doi.org/10.23960/jpmipa/v23i3.pp1195-1204
Sunzuma, G., Zezekwa, N., Gwizangwe, I., & Zinyeka, G. (2021). A Comparison of the Effectiveness of Ethnomathematics and Traditional Lecture Approaches in Teaching Consumer Arithmetic: Learners' Achievement and Teachers' Views. *Pedagogical Research*, *6*.
Supiyati, S., Hanum, F., & Jailani. (2019). Ethnomathematics in Sasaknese Architecture. *Journal on Mathematics Education*, *10*(1), 47–57. https://doi.org/10.22342/jme.10.1.5383.47-58
Supiyati, S., Hanum, F., & Jailani. (n.d.). Ethnomathematics in Sasaknese Architecture. *Journal on Mathematics Education*, *10*, 47–58.
Supriadi. (2022). Elementary school students reflection: Didactical design analysis on integer and fraction operations on mathematical concepts with Sundanese ethnomathematics learning. *Pegem Journal of Education and Instruction*, *12*(4), 192–199. https://doi.org/10.47750/pegegog.12.04.19
Turmuzi, M., Sudiarta, I.G.P., & Suharta, I.G.P. (2022). Systematic Literature Review : Etnomatematika Kearifan Lokal Budaya Sasak. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *6*(1), 397–413.
Umbara, U., Wahyudin, W., & Prabawanto, S. (2021). How to predict good days in farming: Ethnomathematics study with an ethnomodelling approach. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, *6*(1), 71–85. https://doi.org/10.23917/jramathedu.v6i1.12065
Utami, N.W., Sayuti, S.A., & Jailani. (2019). Math and Mate in Javanese Primbon: Ethnomathematics Study. *Jurnal on Mathematics Education*, *10*(3), 341–356. https://doi.org/10.22342/jme.10.3.7611.341-356