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EXPLORATION OF ETHNOMATHEMATICS RESEARCH IN INDONESIA 2010-2023

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ABSTRACT

Ethnomathematics is the finding of mathematics in the cultural values of a place. Indonesia has many kinds of cultures, and ethnomathematics research has been done in some areas of Indonesia. This study aims to identify the cultural forms and mathematical materials found in ethnomathematical research in Indonesia. The research method used is a literature review. The stages of the research method included selecting a topic, developing tools of argumentation, searching the literature, surveying the literature, critiquing the literature, and writing the thesis. The instruments used were Google Scholar, the search engine, and the NVivo application. The number of articles analyzed was 88 articles. These articles represent the culture spread across 34 provinces of Indonesia. The research results obtained are cultural forms containing mathematical material, including ideas, activities, and artifacts. Mathematical materials explored in these cultures include statistics, trigonometry, vector, algebra, arithmetic, one-dimensional geometry, two-dimensional geometry, three-dimensional geometry, coordinate geometry, transformation geometry, calculus, logic, and opportunity. The complexity of the culture and material found in mathematics shows that ethnomathematical research can be developed in all forms of culture and applied in various mathematics learning materials.

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1. INTRODUCTION

Ethnomathematics places mathematics in a social, cultural, and historical context (Lerman, 2000). Ethnomathematics also generates different knowledge due to efforts to cope with different environments (D'Ambrosio, 2016). Ethnomathematics contributes to restoring cultural dignity, increasing creativity, strengthening cultural self-esteem, and offering a broad view of humankind (D'Ambrosio, 1999, 2017). Ethnomathematics also provides a harmonious relationship among humans and between humans and nature (D'Ambrosio,

2007). Ethnomathematics can be defined as practised cultural mathematics in a particular place involving the mathematical identification of slang, codes, symbols, myths, and socio-cultural behaviour (D'Ambrosio, 1985). Ethnomathematics is more acceptable to the public because it is more applicable and exciting than formal mathematics (D'Ambrosio, 2016). Besides being able to improve the development of ethnomathematics itself, this nature of ethnomathematics can also be a solution to problems that exist in mathematics learning and cultural preservation. The issue that commonly happens in learning mathematics is hated, complicated, and boring learning (Kulkin, 2016).

The ethnographer's role in ethnomathematics is working in different cultural environments. It also describes mathematical ideas and other cultural practices. The scope of this culture is not only indigenous people but also includes workers, craftsmen groups, urban communities, agriculture, professional groups, etc (D'Ambrosio, 2007). Ethnomathematics is a collection of theories taken from quantitative and qualitative practices, including counting, weighing and measuring, comparing, sorting, and classifying (D'Ambrosio, 1999). Ethnomathematics investigates how "ad hoc" practices and problem solutions are developed into methods, how methods are developed into theories, and how ideas develop into scientific discoveries (D'Ambrosio, 2007).

Ethnomathematics in Indonesia is growing rapidly. The formation can see the development of an association that overshadows it. This ethnomathematical association is known as the Ethnomath Association. According to the President of the Association's report at the 2nd Conference of the Ethnomath Association, it was known that the Ethnomath Association was founded on October 27, 2018, located at Yogyakarta State University, Indonesia. This association is a professional organization engaged in education and learning mathematics based on culture. This association aims to develop progressive and innovative culture-based mathematics education and learning. This association has also expanded to Aceh, precisely at Syiah Kuala University. The announcement of the name of the association's management was carried out on September 24, 2019. This ethnomathematics also cannot escape the attention of the Indoms (Indonesian Mathematical Society) organization. This is evident from the organizational structure, which has a special field regarding ethnomathematics. In the central structure there is the Field of Ethnomathematics. This field aims to assist the commission coordinator and is responsible for activating scientific activities in ethnomathematics. This field of ethnomathematics is not only found in the center, but also in the regions. The areas where ethnomathematics is located are Yogyakarta and Central Java; Kalimantan; Sulawesi and Gorontalo. This development of ethnomathematics also occurred in research conducted in Indonesia. Using the Google Scholar search engine on December 31, 2023, the search results using the keyword "etnomathematika" can find 9694 articles. The word "etnomathematika" is an Indonesian form of the phrase ethnomathematics.

The number of ethnomathematical studies that have been carried out makes the need for a study that aims to describe the results of these previous studies. This is in accordance with other studies that have been conducted on the research on realistic mathematics education (RME) learning. This study revealed various forms of mathematical material that can be discussed using RME (Prahmana et al., 2020). This research does not only want to display the mathematical material found in ethnomathematics studies in Indonesia. However, this research also aims to reveal what forms of Indonesian culture are related to ethnomathematics. This is very necessary to display the forms of culture and materials, and it helps teachers use them in the learning process easier. The teachers can use ethnomathematics to eliminate students' negative attitudes towards mathematics. This negative attitude towards mathematics can cause anxiety, making students stay away from mathematics (Choe et al., 2019). One of the efforts teachers can make in dealing with this

problem is ethnomathematics. Ethnomathematics in education can eliminate confusion about mathematical knowledge as final, permanent, absolute, and unique expertise (D'Ambrosio, 2007).

2. METHOD

The method used was a literature review. The processes done were 1) selecting the topic, 2) developing tools of argumentation, 3) searching the literature, 4) surveying the literature, 5) critiquing the literature, 6) writing the thesis (Machi & McEvoy, 2009). The details of these steps are as follows.

2.1. Step 1: selecting a topic

Ethnomathematics is one of the fascinating educational studies to study. This is because the learning is carried out by combining culture and mathematics. Indonesia is famous for its cultural diversity. With this diversity, what is the form of ethnomathematics that occurs?

2.2. Step 2: developing tools of argumentation

The development of ethnomathematics in Indonesia at this time needs to be investigated. Because Indonesian culture is very diverse, it is also possible to develop ethnomathematics. Identification of this ethnomathematical development can be made by looking at the research results that have been done. The results of these studies can be found in scientific publications. Publication of scientific works can be in articles in journals or proceedings.

2.3. Step 3: searching the literature

The search engine for research articles is very diverse, and one of them is scholar.google.com. Google Scholar is a complete search engine because Google Scholar indexes almost all journals in Indonesia. The process of searching for publications of ethnomathematics research results using Google Scholar is 1) the first keyword used was "etnomatematika". This is because "etnomatematika" is an ethnomathematics word in Indonesian. 2) The next keyword, namely "etnomatematika", was added with the province's name in Indonesia. The addition of the province's name was also complemented by the word "intitle". This was because that the search results became more specific. For example, the search word is "etnomatematika AND intitle: Aceh". 3) The Search used the keyword ethnomathematics and the province's name in Indonesia. The search processes for this article were carried out from February 14, 2023, to December 31, 2023. The search results obtained 9694 articles. All of these articles were spread from 2010 to 2023.

2.4. Step 4: survey the literature

At this step, the selection of the obtained articles was carried out. The selection process was based on the coverage of articles in all provinces of Indonesia. The techniques were done at this step, namely 1) looking for articles that mention the province's identity.To maintain the confidence level of articles, the articles in the data are articles whose title includes the province's identity. The number of articles obtained was 252 articles. Of these 252 articles, the distribution is diverse. Some provinces have more than three articles, some have only one or two, and some are not found. The provinces that were not found were North Kalimantan and West Nusa Tenggara. 2) To obtain a representation of ethnomathematics articles from each region, other search terms are used, such as the name of the district, the

name of the culture, or the name of the city in the province. The results of this search contained four additional articles. 3) choose articles in each province with the highest citations. Only the three with the most citations were taken for provinces with more than three articles. This aims to make the analysis process more even. For provinces with data for only 1 or 2 articles, continue using those articles without adding other articles. The number of articles obtained at this stage was 88 articles. The steps taken can be described according to Figure 1.

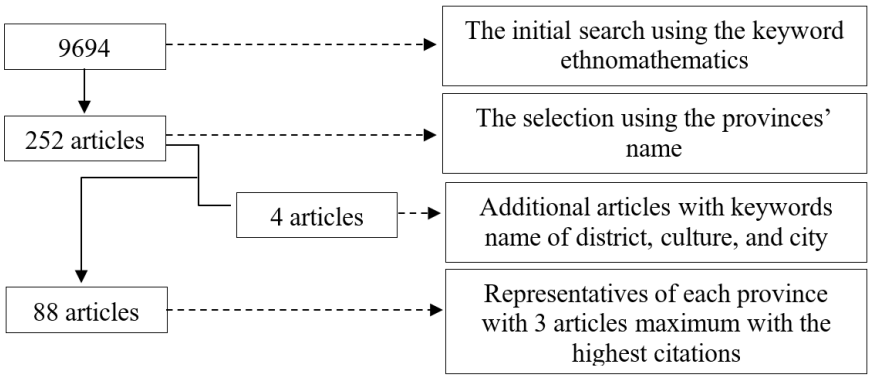


Figure 1. Article selection process

2.5. Step 5: critiquing the literature

At this step, an analysis was carried out using NVivo 12. The process carried out was coding the cultural forms and mathematical materials in the 88 articles.

2.6. Step 6: writing the thesis

The process at this step was to represent the results of NVivo and then analyzed how ethnomathematics was formed in Indonesia.

3. RESULT AND DISCUSSION

The development of ethnomathematical research in Indonesia can be seen from research results. When a search was done using the Google Scholar search engine on December 31, 2023, there were many articles each year that could be seen in Figure 2. The papers related to ethnomathematics are increasing from year to year. In 2010 there were only two articles, and in 2023 it reached 9694 articles. When compared to previous years, the most significant growth occurred in 2021. In 2021, there was an increase in the number of articles by 886 articles. In fact, this data had some weaknesses; they were 1) only using the keyword "etnomatematika", and 2) only using the Google Scholar search engine. This data did not describe accurate data about the number of ethnomathematical articles in Indonesia. This data showed that the number of ethnomathematical research in Indonesia would be more than if the search used additions to the search word and the search engine.

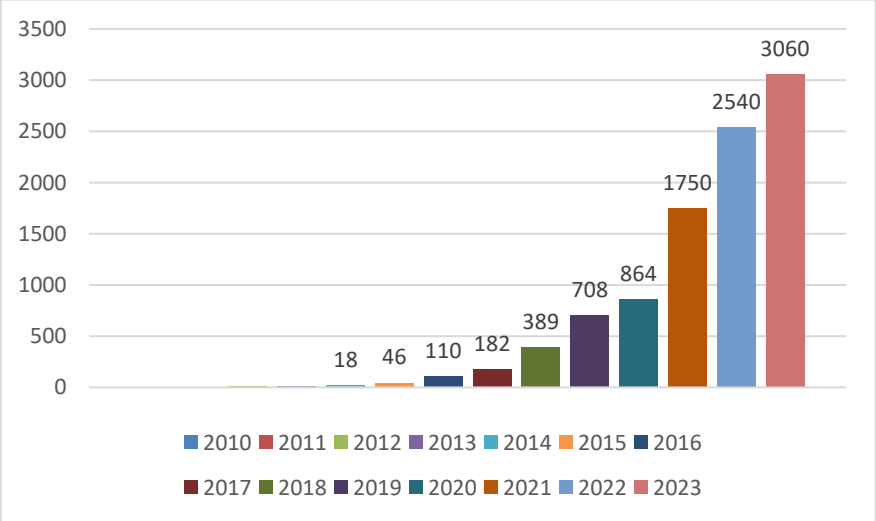


Figure 2. Number of search result articles using google scholar with the keyword "etnomatematika"

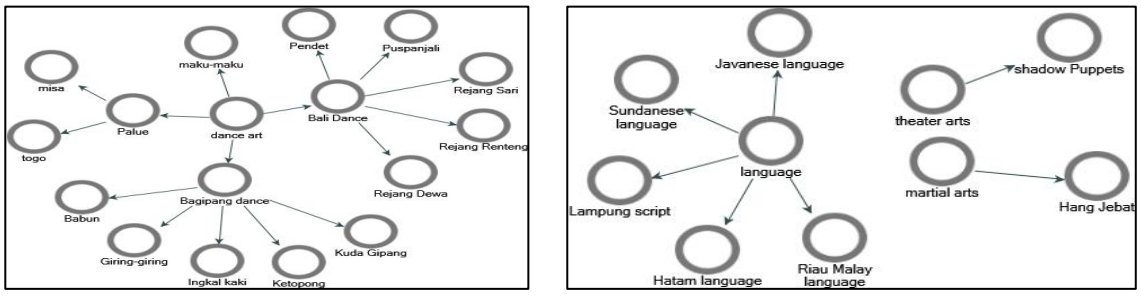
The articles were spread throughout the provinces of Indonesia. Then the data is made into groups according to each province. This aimed to obtain the representation of articles in each province. According to step 3, they were 88 articles representing 34 provinces in Indonesia. The article is contained in Table 1.

Table 1. Articles representing ethnomathematics research in Indonesia

No	Province	Article Author & Year
1	Nanggroe Aceh Darussalam	(Hakim et al., 2020; Usnul et al., 2019)
2	North Sumatra	(Astuti, 2019; Dewita et al., 2019; Kusuma, 2019)
3	South Sumatra	(Lisnani et al., 2020; Manullang et al., 2018; Sari et al., 2018)
4	West Sumatra	(Fauzan et al., 2020; Rahmawati & Muchlian, 2019; Syahriannur, 2019)
5	Bengkulu	(Febriani et al., 2019; Lubis & Yanti, 2018; Widiarti et al., 2019)
6	Riau	(Fendrik et al., 2020; Hasanuddin, 2017; Zulfah et al., 2023)
7	Riau Islands	(Sahilda & Izzati, 2020; Taur et al., 2020; Wicaksono et al., 2020)
8	Jambi	(Hardiarti, 2017; Muslimahayati & Wardani, 2019; Sutrimo et al., 2023)
9	Lampung	(Pratami et al., 2018; Rakhmawati et al., 2018; Susiana et al., 2020)
10	Bangka Belitung	(Dasaprawira et al., 2019; Gunawan, 2019; Nurdiani et al., 2020)
11	West Kalimantan	(Dian, 2021; Purnama et al., 2020; Surmiyanti et al., 2021)
12	East Kalimantan	(Dimpudus & Ding, 2019; Edi, 2021)
13	South Kalimantan	(S. Dewi et al., 2019; Ekawati et al., 2019; Helmina et al., 2022)
14	Central Kalimantan	(Annisa, 2019; Arifin & Fortuna, 2021; Syar et al., 2021)
15	North Kalimantan	(Fitri et al., 2019)
16	Banten	(Subekhi et al., 2021; Subekhi & Oktavia, 2021; Syari et al., 2022)
17	DKI Jakarta	(Aprilyani & Hakim, 2020; Faturrahman & Soro, 2021)
18	West Java	(Muslim & Prabawati, 2020; Prabawati, 2016; Resfaty et al., 2019)
19	Central Java	(Nursyahidah et al., 2018; Zaenuri & Dwidayati, 2018; Zaenuri et al., 2019)

No	Province	Article Author & Year
20	D. I. Yogyakarta	(Andriani & Septiani, 2020; Huda, 2018; Prahmana & D'Ambrosio, 2020)
21	East Java	(Aprilianti et al., 2019; Hariastuti, 2018; Hariastuti et al., 2019; Hidayatulloh & Hariastuti, 2018)
22	Bali	(L. I. P. Dewi et al., 2019; Diputra et al., 2022; Suarjana et al., 2014)
23	East Nusa Tenggara	(Bunga et al., 2018; Elannor, 2019; Theresia et al., 2019)
24	West Nusa Tenggara	(Kusaeri & Pardi, 2019; Sabilirrosyad, 2016; Supiyati et al., 2019)
25	Gorontalo	(Anwar et al., 2015; Attaufiq et al., 2014; Lasalewo et al., 2017)
26	West Sulawesi	(Ajmain et al., 2020; Samad et al., 2020)
27	Central Sulawesi	(Isnawati & Putra, 2017; Mawaddah, 2017)
28	North Sulawesi	(Kaunang et al., 2018)
29	Southeast Sulawesi	(Marzuki et al., 2019; Yanti et al., 2018)
30	South Sulawesi	(Jainuddin et al., 2020; Sulasteri et al., 2020; Tandililing, 2015)
31	North Maluku	(Tayeb et al., 2015)
32	Maluku	(Laurens et al., 2019; Sopamena & Juhaevah, 2019; Sopamena & Yapono, 2016)
33	West Papua	(Haryanto et al., 2016; Haryanto et al., 2017; Ubayanti et al., 2016)
34	Papua (special area)	(Nainggolan & Abraham, 2018)

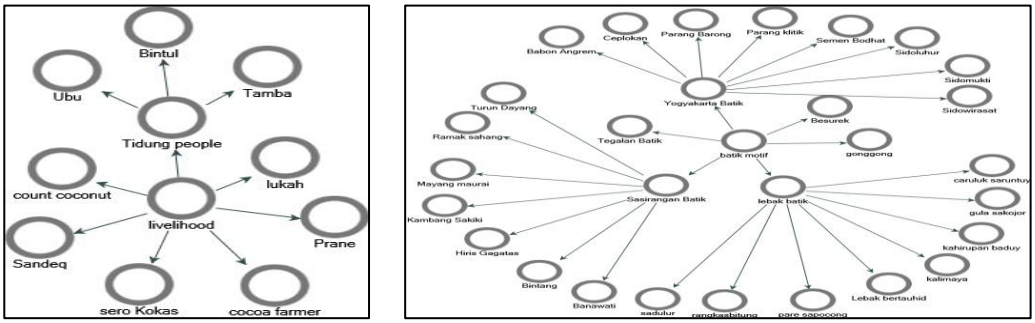
After all provinces had been represented; the following process was coding. The coding was done by looking at that culture's cultural form and mathematical material. Culture consists of three states, namely ideas, activities, and works. Mathematical material was based on all elements in mathematics, both base mathematics and applied mathematics. The results of the coding of 88 articles on cultural forms were various cultural forms that these articles had studied. The details of the culture can be seen in the following Figure 3.



(a) (b)

Figure 3. Representation of analysis results: (a) dance art; (b) language, theatre art, and martial art

From Figure 3a, it can be seen that the cultural form of ethnomathematics is dance. These traditional dances include Balinese dance, Bagipang dance, Palue dance, and Maku-maku dance. Figure 3b shows that the cultural conditions are theatre, language, and martial arts. The language involving mathematical values are Javanese, Sundanese, Lampung, Hatam, and Riau Malay. Furthermore, for theatrical arts that use ethnomathematics, only shadow puppets, and for martial arts is Hang Jebat.

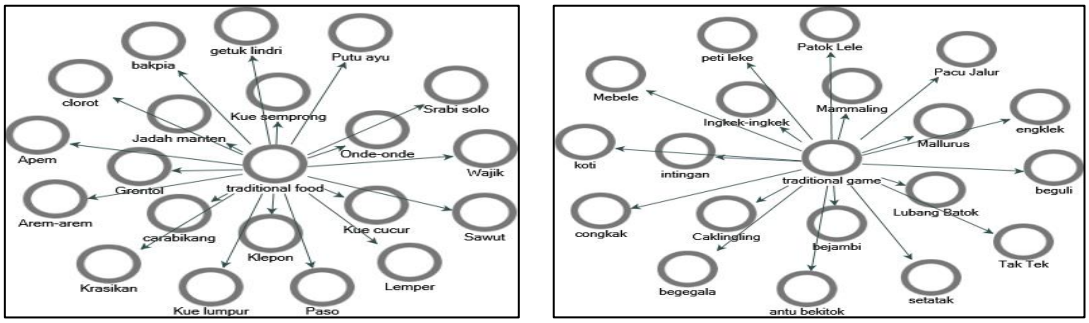


(a) (b)

Figure 4. Representation of analysis results: (a) livelihood; (b) batik motif

The other ethnomathematics cultures are livelihood, traditional activities, and traditional market. It can be seen from Figure 4a that livelihood consists of count coconut, Sandeq, sero Kokas, cocoa farmer, prane, lukah, and tidung people. Tidung people consist of ubu, bintul, and tamba. In Figure 4b, it can be seen that the Batik motifs that have ethnomathematical elements consist of Yogyakarta batik, Besurek batik, Gonggong batik, Lebak batik, Sasirangan batik, and Tegalan batik. Yogyakarta batik motifs consist of angrem baboon motifs, ceplokan, barong machetes, klitik machetes, cement bodhat, sidoluhur, sidomukti, and sidowirasat. Sasirangan batik motifs consist of turun dayang, ramak sahang, mayang maurai, sakiki flowers, hiris gagatas, stars, and banawati motifs. The lebak motif consists of caruluk saruntuy, sugar sakojor, kahuripan baduy, kalimaya, lebak bertauhid, pare sapocong, rangkasbitung, and sadulur.

Ethnomathematics is also found in traditional food culture and traditional games. In Figure 5a we can see that traditional foods that use ethnomathematics consist of “getuk lindri”, “putu ayu”, “srabi solo”, “wajik”, “sawut”, “lemper”, “paso”, “kue lumpur”, “krasikan”, “arem-arem”, “apem”, “clorot”, “bakpia”, “semprong”, “onde –onde”, “kue cucur”, “klepon”, “carabikang”, “grontol”, and “jadah manten”. Figure 5b illustrates that the ethnomathematical forms of traditional games include “patok lele”, “pacu jalur”, “engklek”, “beguli”, “tak-tek”, “setatak”, “antu begitok”, “benggala”, “congkak, koti”, “mebele”, “peti leke”, “mammaling”, “mallurus”, “lubang batok”, “bejambi”, “caklingling”, “intingan”, and “ingkek-ingkek”.

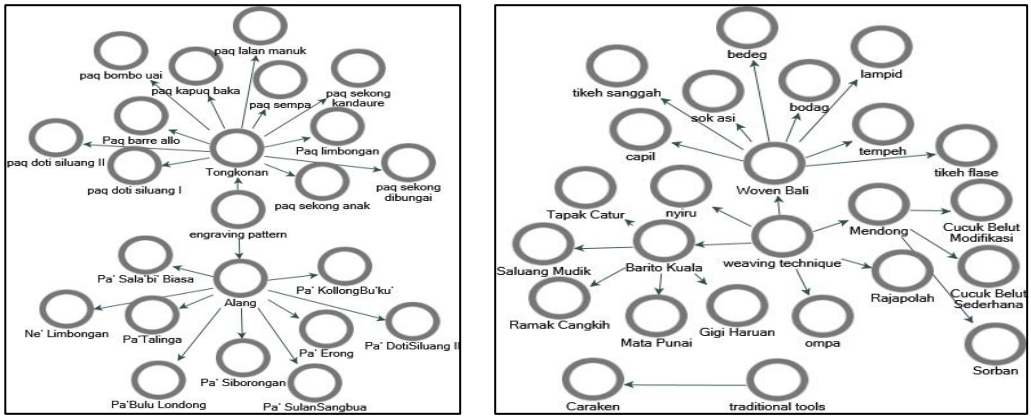


(a) (b)

Figure 5. Representation of analysis results: (a) traditional food; (b) traditional games

Figure 6a shows that cultural forms that contain ethnomathematical elements in the engraving pattern are alang and tongkonan. Alang culture consists of pa' kallongbuku, pa' dotisiluang II, pa' erong, pa' sulansangbua, pa' siborongan, pa' bulu londong, pa' talinga, ne'limbongan, and ordinary pa' sala'bi. Tongkonan culture consists of paq doti siluang I, paq doti siluang II, paq barre allo, paq bombo uai, paq kapuq baka, paq lalan manuk, pak sempa, pack sekong kandaure, paq limbongan, pak sekong dibungai, and paq sekong anak. Figure

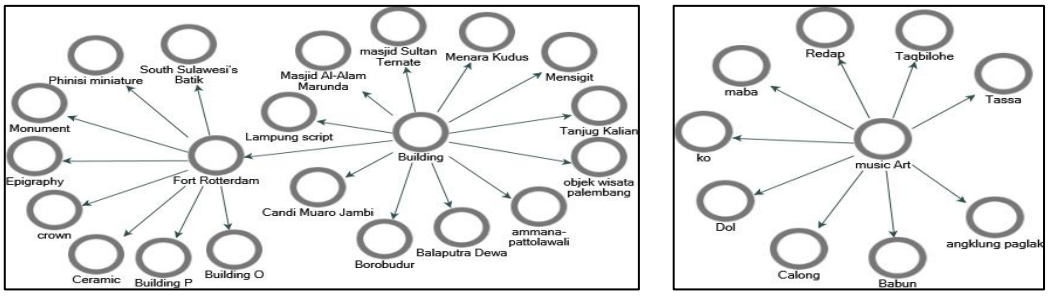
6b shows the weaving technique and traditional tools. The weaving technique consists of ompa, nyiru, rajapolah, mendong, barito kuala, and Balinese woven. Barito kuala consists of chess tread techniques, saluang mudik, cangkih ramak, punai eyes, and haruan teeth. Mendong consists of modified eel beak technique, simple eel beak, and turban. Woven Bali consists of capil technique, tikeh sanggah, so kasi, bedeg, bodag, lampid, tempeh, and tikeh flase.



(a) (b)

Figure 6. Representation of analysis results: (a) engraving pattern; (b) weaving technique and traditional tools

In Figure 7a it can be seen that cultural forms that use ethnomathematical elements in the building include the Lampung script, Al-Alam Marunda Mosque, Sultan Ternate Mosque, Kudus Tower, Mensigit, Tanjung Kalian, Palembang Tourism Object, Ammana-pattolawali, Balaputra Dewa, Borobudur, Muoro Jambi Temple, and Fort Rotterdam. At Fort Rotterdam, there is a culture of building O, Building P, ceramic, crown, epigraphy, monument, phinisi miniature, and south Sulawesi's batik. In Figure 7b, we can see the art of music culture with ethnomathematical elements. These cultures include angklung pagak, baboons, Calong, dol, ko, maba, redap, taqbilohe, and tassa.

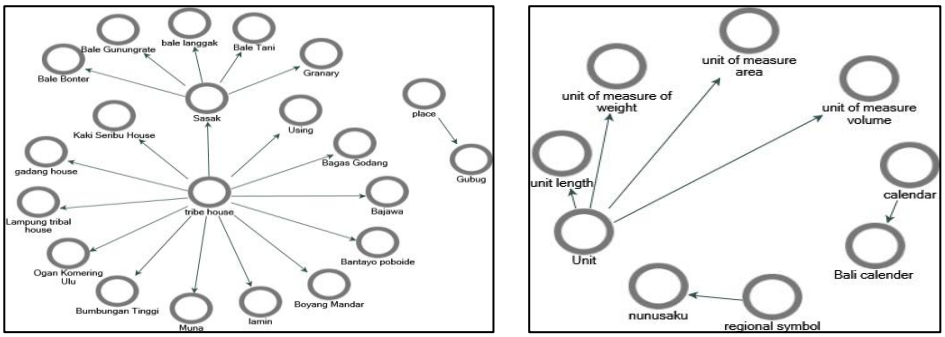


(a) (b)

Figure 7. Representation of analysis results: (a) building; (b) music art

Ethnomathematics is also found in the culture of the tribe house and place, unit, calendar, and regional symbol. In Figure 8a, we can see that the culture of the tribe house and place contains ethnomathematics elements. The culture of the tribe house that has ethnomathematics is using, bagas godang, bajawa, bantayo proboide, boyang mandar, lamin, muna, bumbungan tinggi, ogan komering Ulu traditional house, Lampung tribal house, gadang house, kaku seibu house, and the traditional Sasak house. In traditional Sasak houses there are various forms, namely bale bonter, bale gunungrate, bale langgak, bale tani, and granary. The place where there is an ethnomathematical element is the hut. Figure 8b shows

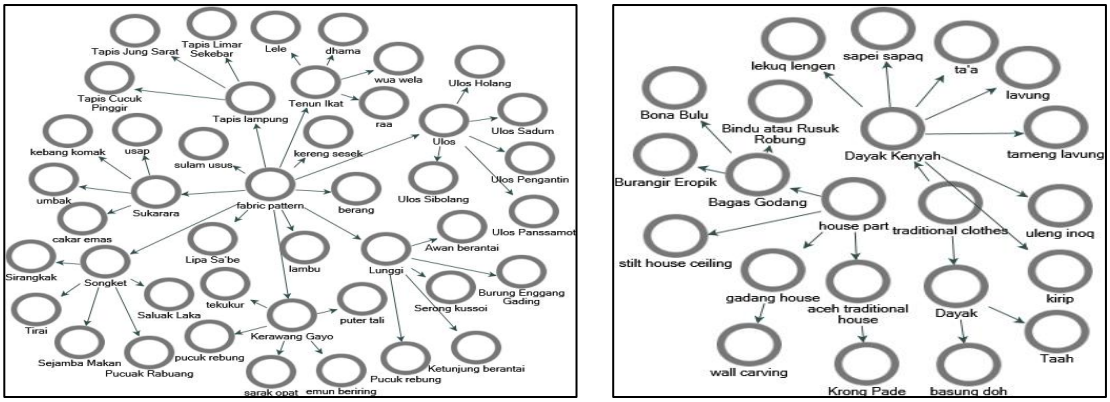
the culture in units, calendars, and regional symbols. In the unit form, there are units of length, units of weight measurement, units of area measurement, and units of volume measurement. The calendar culture contained in the articles analyzed is the Balinese calendar. Culture in the form of regional symbols, namely nunusaku.



(a) (b)

Figure 8. Representation of analysis results: (a) tribe house and place; (b) unit, calendar, and regional symbol

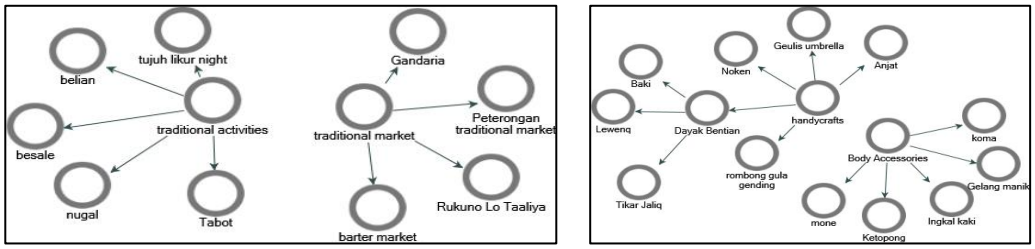
Ethnomathematics is also found in fabric patterns, house parts, and traditional clothes. In Figure 9a we can see that the fabric pattern can be in the form of berang, lambu, lipa sa'be, sulam usus, kereng sesek, lunggi, kerawang gayo, songket, sukarara, tapis lampung, tenun ikat, and ulos. Lunggi consists of awan berantai, burung enggang gading, serong kussoi, ketunjung berantai, pucuk rebung. Kerawang gayo consists of dari puter lali, emun beriring, sarak opat, pucung rebung, dan tekukur. The songket motifs consist of saluak laka, pucuak rabuang, sejamba makan, tirai, dan sirangkak. The Sukarara cloth motif consists of cakar emas, umbak, kembang komak, dan usap. The Lampung tapis cloth motif consists of tapis cucuk pinggir, tapis jung sarat, dan tapis limar sekebar. Tenun Ikat motifs consist of lele, dhama, wua wela, dan raa. Ulos motifs consist of ulos holang, ulos sadum, ulos pengantin, dan ulos panssamot. In Figure 9b, we can see the form of culture in the house part and traditional clothes which have ethnomathematical elements. The culture in the house part consists of krong kode, wall carving, stilt house ceiling, dan bagas godang. In Bagas Godang, there are burangir eropik, bona bolu, dan bindu atau rusuk robung. The culture in traditional clothes consists of Dayak clothes and Kenyah Dayak clothes. In Dayak clothing, the cultural forms are taah and basung doh. In Kenyah Dayak clothing, the cultural forms are lekuq lengen, sapei sapaq, ta'a, lavung, tameng lavung, uleng inoq, and kirip.



(a) (b)

Figure 9. Representation of analysis results: (a) fabric pattern; (b) house part and traditional clothes

Figure 10a shows that cultural forms that use ethnomathematical elements consist of traditional activities and traditional markets. Traditional activities consist of seven likur night, belian, besale, traditional nugal, and tabot. The traditional market consists of gandaria, Peterongan traditional market, Rukuno lo Taaliya, and barter market. In Figure 10b, it can be seen that ethnomathematics is also found in handicrafts and body accessories. The handicrafts consist of anjat, geulis umbrella, noken, rombong sugar gending, and Dayak bentian. Bentian Dayak consists of trays, lewenq, and jaliq mats. Body accessories include commas, beaded bracelets, anklets, helmets, and mones.



(a) (b)

Figure 10. Representation of analysis results:(a) traditional activities and traditional market; (b)handicrafts and body accessories

All the forms of culture are then grouped into three forms of culture. Figure 11 shows that culture in Indonesia, which contains ethnomathematical elements, can be grouped into three forms of culture, namely ideas, activities, and artefacts. Cultural conditions in ideas consist of units, calendars, and regional symbols. Regional symbols include ideas instead of artefacts because they contain a more substantial traditional philosophy than just an object. Cultural forms in activities consist of language, livelihood, martial arts, theatre arts, traditional activities, traditional food, traditional games, traditional market, and dance art. Cultural forms in the artefacts group are weaving technique, batik motifs, body accessories, building, engraving patterns, fabric patterns, handicrafts, house parts, music art, place, traditional clothes, traditional tools, and tribe house. The number of forms of these artefacts is the most compared to other cultural forms.

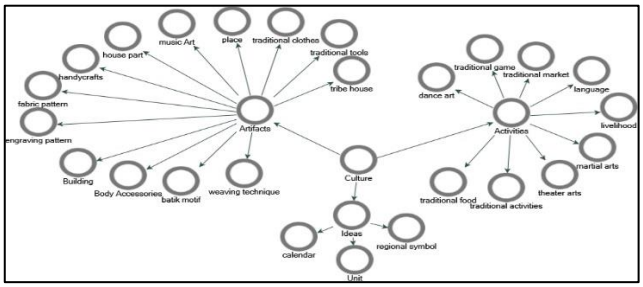


Figure 11. Culture grouping

The selected articles make it possible to know the form of culture and the mathematical material. The mathematics material is extracted from cultures. The Mathematical material removed from the culture in Indonesia can be seen in the following Figure 12.

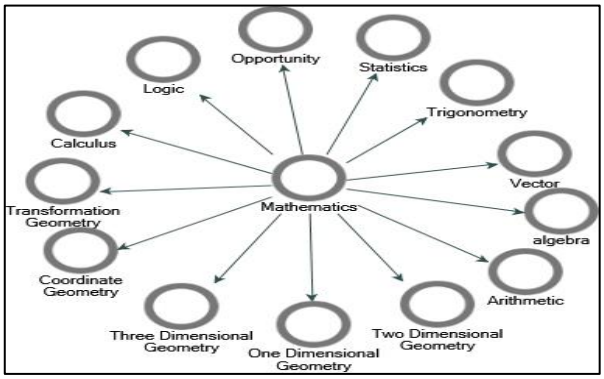


Figure 12. Mathematics material extracted

From Figure 12, it can be seen that mathematical material can be found from the culture of Indonesia. The material includes statistics, trigonometry, vector, algebra, arithmetic, one-dimensional geometry, two-dimensional geometry, three-dimensional geometry, coordinate geometry, transformation geometry, calculus, logic, and opportunity. This mathematical material that can be found includes almost all mathematical material. This scope gives the teacher an idea that ethnomathematics can be applied in the learning process. Teachers can use culture as a learning material to be contextually based learning process (Nur et al., 2020; Utami et al., 2019).

Cultures that contain elements of ethnomathematics are very diverse. This illustrates to researchers that there are still many opportunities to explore existing cultural forms. This opportunity occurs because Indonesian culture is varied, and many cultures have not been studied. Even though reviewing the same culture may provide a chance for different perceptions regarding mathematics material. This is because ethnomathematics is a form of ethnographic research where the main instrument is the researcher himself (Adam, 2010).

4. CONCLUSION

The diversity of Indonesian cultural forms can be explored for its ethnomathematics elements. The cultural form that contains mathematical material can be ideas, activities, and artefacts. Mathematical materials that can be explored include statistics, trigonometry, vector, algebra, arithmetic, one-dimensional geometry, two-dimensional geometry, three-dimensional geometry, coordinate geometry, transformation geometry, calculus, logic, and opportunity.

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