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Ethnomathematical research in mathematics education journals in Indonesia: A case study of data design and analysis

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Abstract
In 2016, Indonesian ethnomathematical research emerged, which led to the publication of various journals ranging from science and technology index (SINTA) one to six. Comprehensive studies on this trend, is very important for advancing ethnic mathematics and learning. Therefore, this research aimed to determine trend in ethnomathematics in Indonesia, from the design to data analysis stages. It adhered to the principle of content analysis with a focus on the results of published scientific-related journals. Data were collected from the content analysis results of mathematics education articles published from 2016 to 2022, with the keyword ethnomathematics and of the 80 research, none used this type of classroom action method. The literature review comprises one, two, 10, and 18, normal, mixed method, quantitative, and development-related articles, respectively. The most dominant was qualitative, with 49 articles. In conclusion, the trend of Indonesian ethnomathematical research publications has increased more than in previous years, with the highest number achieved in 2021.

Keywords: trend, ethnomathematics, ethnomathematical research, Indonesia mathematics education

INTRODUCTION

Indonesia has diverse, unique, and rich cultures, which exposes it to the chance to revolutionize its educational system, specifically mathematics, by relating the subject to students' daily activities and cultural norms (Abdullah et al., 2019; Tutak et al., 2011). This can be properly understood, by investigating a variety of customs, including the special region of Yogyakarta, also known as the city of culture (Risdiyanti & Prahmana, 2018). Temples, palaces, mosques, and batik designs with distinctive and one-of-a-kind shapes are a few examples of the numerous cultural items easily explored in Yogyakarta. In addition, it instills in students historical and philosophical values that are significant in molding their characters. These include self-assurance, sympathy, empathy, respect for others, concern for social issues, and a sense of responsibility (Widodo, 2019). According to Prahmana et al. (2021), ethnomathematics does not only end with exploration and cultural experimentation of mathematics education in schools, rather it can also be re-introduced in future.

One of the difficulties presently faced by mathematics teachers is how to successfully provide students with mathematical rules and contents in a more efficient and fun manner. This is because the past few years have been centered on cultural donations to promote this subject in schools. The debated issue is, "can teaching mathematics that involves the incorporation of cultural values related to students' daily activities contribute to a more meaningful learning, better achievement, and greater motivation?" (Fouze & Amit, 2018a). Several research have been carried out to respond to this problem, and teachers have implemented different curricula worldwide. Preliminary research that endorsed this idea suggested a solution, namely the use of ethnomathematics with the incorporation of cultural concepts and values when teaching this subject. Its adoption in the classroom aids in forming students' talents and abilities concerning significant descriptions and quality achievement in mathematics (D'Ambrosio, 2001; Lipka et al., 2011; Verner et al., 2013). A research was also carried out in Nigeria to identify the effectiveness of the ethnomathematical approach on

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Contribution to the literature

- The trend of increasing the number of publications on ethnomathematical research shows that several research were eager to investigate it in Indonesia. The provinces used as the object are mostly located in East Java, Nusa Tenggara, and Lampung. The finished ethnographic qualitative research design is widely used in Indonesia.
- Learning mathematics by applying ethnomathematics concepts contributes to helping students understand the materials, specifically those concerning flat and space buildings. Its contribution is evident in the improvement of the learning outcomes.
- Ethnomathematics is an inseparable part of people's lives. Therefore, it needs to be applied during learning, specifically when teaching mathematics at the elementary school level.

students' memories and proficiencies in the geometric locus notion. The findings showed that those taught with this approach had greater retention and average achievement scores than traditional (Achor et al., 2009).

There is still no consensus on "how does mathematics grow", which is debated until now. Baki (2020) investigated its history and reported that this subject has a connection with philosophy. Besides, cultural values play a vital role in the origin and evolution of mathematical thought systems (Sam & Ernest, 1997). This led to the emergence of a research field called "ethnomathematics", which deals with the bond between culture and mathematics. The development is negatively affected by the idea that mathematics is independent of culture (Gerdes, 2004). In the area of mathematics education, research on ethnomathematics has been attempted with participants of all ages, from preschool to major learning, utilizing quantitative and qualitative methodologies. This present research discovered that this approach triggers achievement (Moreno & Magallanes, 2003), improves mathematical description (Widada et al., 2018), thinking skills (Iluno & Taylor, 2013), and positive behavior toward this subject (Aktuna, 2013). Furthermore, the research of ethnomathematics enables students to gain cultural understanding (Zavlavsky, 1998).

Adopting an ethnomathematical approach is fascinating and makes it easier for students to master and impart the lesson experiences encountered daily (Meaney & Lange, 2013). However, D'Ambrosio and Rosa (2016) initiated this approach based on mathematically mechanistic teaching, formulae, and abstract structures, far from the realities of being a student.

Since the conception in 1977, ethnomathematics has continued to be developed based on the shared ideas of D'Ambrosio (2001) through publications and lectures at numerous conferences. Karnilah et al. (2013) explored its special knowledge in mathematics learning. This process started with Baduy residents who have not been exposed to formal education but have improved their mathematical abilities due to daily experiences. Several related research on von Indonesian cultures have been widely spread and published in innumerable magazines. According to Hidayati and Prahmana (2022, p. 30) these publications were affected by many factors and diverse customs that exist from Sabang to Merauke, which drew the attention of academics and instructors.

In 2016, numerous articles witnessed the proliferation of ethnomathematics between science and technology index (SINTA) one and six. However, there has never been a thorough investigation of Indonesia's tendency to date, which is one of the main reasons for conducting this study. This present research aims to survey the trend in the country, from design to information analysis procedures. In some ways, it differs from those concentrating on ethnomathematics using broader illustrations (Hidayati & Prahmana, 2022). Initially, all publications made between 2010 and 2021, accredited by SINTA, were the subject of this research. It also aims to review several articles by analyzing different variables to share ideas for Indonesian science, particularly in mathematics learning.

Irrespective of the fact that similar research has been widely carried out, there is limited empirical evidence reporting the impact of ethnomathematics-based learning on students. Some research tended to concentrate on ethnomathematics or cultural contextualization. However, preliminary research can be categorized into three groups. The first is focused on the utilization of mathematics in various cultures. The creation of cultural craft, and fashion sites in Indonesia and the Philippines involves the use of ethnomathematical concepts for estimation, measurement, and pattern building (Mania & Alam, 2021; Maryati & Prahmana, 2019; Muhtadi et al., 2017; Rubio, 2016). The research within the second category included analyzing how ethnomathematics is used in mathematics education. These were carried out in Hawaii (Furuto, 2014), Israel (Fouze & Amit, 2018b), and Indonesia (Hartinah, 2019), particularly in the field of geometry (Sunzuma & Maharaj, 2019; Supriadi, 2020; Verner et al., 2013). The third category emphasizes how adept teachers are at imparting knowledge of mathematics using the ethnomathematical approach, both in Indonesia and Papua New Guinea (Owens, 2014; Sintawati et al., 2019).

Table 1. Aspects and categories used for content analysis

Aspect	Category
Number of publications per year	A1-2016, A2-2017, A3-2018, A4-2019, A5-2020, & A6-2021
Research areas	B1-Sulawesi, B2-Kalimantan, B3-Bengkulu, B4-Jakarta, B5-Sumatera, B6-Aceh, B7-Maluku, B8-Bali, B9-Yogyakarta, B10-Java, B11-Jambi, & B12-Nusa Tenggara
Types of research	C1-R & D, C2-Class action, C3-Qualitative, C4-Quantitative, C5-Mixed, & C6-Literature review
Types of qualitative research	D1-Ethnography, D2-Explorative qualitative, D3-Descriptive qualitative, & D4-Other
Data collection instrument	E1-Questionnaire sheet, E2-Observation sheet, E3-Test sheet, E4-Interview sheet, & E5-Other
Data analysis method	F1-Spradley models, F2-Miles & Huberman, F3-n-gain, F4-t-test, F5-ANOVA, F6-MANOVA, F7-Correlation, F8-ADDIE, & F9-4D models
Research subject	G1-Elementary school students, G2-Junior high school students, G3-Senior high school students, G4-College students, G5-General public, G6-Craftsmen & businessmen, G7-Traditional player, & G8-Other
Ethnomathematical research discussion material	H-1 Graphics & functions, H-2 Rotating object volume, H-3 Permutations & combinations, H-4 Graph theory, H-5 Social arithmetic, H-6 Build flat & curved side rooms, H-7 Arithmetic sequences & series, H-8 Fractions comparison & concept, H-9 Pythagoras theorem, H-10 Set, H-11 Time conversion & temperature conversion, H-12 Congruence, similarity, symmetry, & scale, H-13 Math logic, H-14 Permutations & combinations, H-15 Linear program, H-16 Field analytical geometry, H-17 Measurement, H-18 Mathematical statistics, H-19 Linear equation, H-20 Number patterns & number operations, H-21 Transformation geometry, & H-22 Geometry (platform & space)

Meanwhile, through D'Ambrosio's (2001) publications and lectures delivered at several conferences, ethnomathematics has become well-known since its inception in 1977. The notion that mathematics is independent of culture is beginning to be widely perceived as mistaken. Presently, several research tended to examine the relationship between mathematics and culture. For example, the ethnomathematical research was carried out in the Baduy community. It illustrated that, basically, the Indigenous people do not yet have a written number system, although they have used these concepts in many cultural contexts. This is obtained from two cultural contexts, namely agriculture and the durian fruit sales. This present research commenced with the ethnomathematics analysis of the Baduy people, who had developed and used their knowledge of mathematics to overcome various daily problems, despite not receiving formal education (Karnilah et al., 2013). Preliminary research on diverse Indonesian cultures have been published in various journals, because Indonesia is home to a wide variety of cultures, from Sabang to Merauke, thereby attracting scholars and educators (Hidayati & Prahmana, 2022).

MATERIALS AND METHODS

This present research adhered to the content analysis principle, which focuses on the findings of various research published in Indonesian scholarly journals. Therefore, the procedures employed were similar to those adopted by Fauzi and Pradipta (2018) and Susetyarini and Fauzi (2020).

Data Sources

Information was gathered from the content analysis of mathematics learning articles using the keyword ethnomathematics. All articles were taken from the mathematics learning journals in SINTA in December 2021.

SINTA (http://sinta2.ristekdikti.go.id/) is a platform for measuring the development of science and technology created by Indonesians from the Department of Studies, Higher Education and Technology. A total of 80 mathematics learning articles and 27 journals are contained in the SINTA database. All articles discussing ethnomathematics were collected from each of these journals, including those published online in December 2021, with only 80 on ethnomathematics.

Research Instruments

The instruments used were a content analysis guideline that contains related aspects observed (**Table 1**). There were as many as eight major aspects reviewed in this present research. These include

(1) the number of publications per year,

(2) research areas,

(3) types of research,

(4) types of qualitative research,

(5) data collection instrument,

(6) data analysis method,

(7) research subject, and

(8) ethnomathematical research discussion material.

Unfortunately, aspects (1) and (8) were exempted at the beginning due to a lack of previous research that can be referenced. Therefore, the possibility of excessively

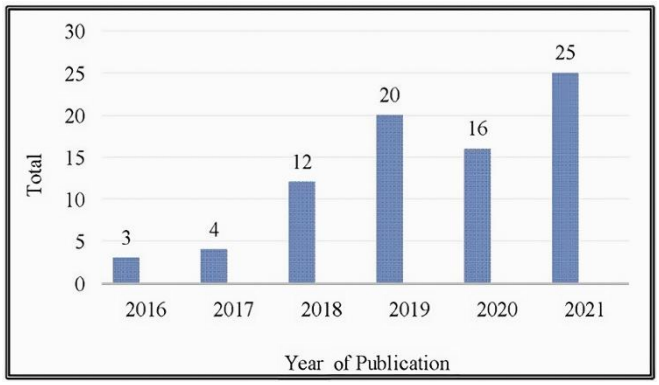

Figure 1. Trend of increasing number of ethnomathematical research in Indonesia in six years (Source: Authors' own elaboration)

generalized categories appears when content analysis on some articles is conducted. The categories in aspects (3), (4), (6), and (7) were determined before the collection of data adapted from Fauzi and Pradipta (2018).

Data Analysis

The data collected were analyzed and presented according to each aspect, as shown in **Table 1**. The presentation was usually in the form of a bar chart model. Each article was classified into a specific group based on specific characteristics that fit the required categories. This was dependent on the data provided in the discussion, method, and abstract sections. Additionally, a bar chart was used to display the information gathered.

RESULTS

The Number of Publications

The number of articles published showed the frequency by which related research were conducted over a given period. However, using the graph in **Figure 1** as a guide, articles that reviewed ethnomathematical research have been available since 2016. There was no particular shift pattern that occurs in the number of publications yearly. Referring to **Figure 1**, the number of publications since 2019 has increased higher than in previous years, reaching its peak in 2021. The pattern of publishing more articles showed a significant rise in research carried out to investigate ethnomathematics in Indonesia.

This is also supported by a similar research on ethnomathematics in Indonesia conducted from 2015 to 2020 by Hidayati and Prahmana (2022). It showed that from 2016 to 2019, there was a maximum increase in published articles, which plummeted in 2020. Hidayati and Prahmana (2022) conducted research to comprehensively examine ethnomathematics within 5 years, starting from 2015 to 2020. Data were collected by obtaining articles from each journal and classifying them based on title, year, journal name, context, mathematical content, research subjects, methods, and materials. The systematics literature review was used to identify 30 articles, while the remaining 50 were analyzed in this present research. Most research were conducted due to the sensitivity to universal issues that are often intertwined, specifically in relation to local culture. One of the cases that are often encountered presently is the low level of teachers' expertise in applying local culture to mathematical concepts. The carrying out of research is perceived as an extremely efficient method to overcome these problems. This is because it helps to identify highly efficient educational designs or media that can accommodate skills relating to the integration of cultural values into mathematical concepts. Many Indonesian cultural values can be integrated into mathematical concepts. According to Choirudin et al. (2021), archaeological objects on the Pugung Raharjo archaeological website was meaningfully used during each era and this can be related to the concepts of mathematics education. There are also listed in the traditional house building, perceived as a local unit for Lampung residents (Rakhmawati, 2016). Mathematical concepts are evident in batik activities, namely flat plane geometry and geometric transformations (Mulyani & Natalliasari, 2020), while Banten culture has various Pythagorean theories (Nirmalasari et al., 2021).

The publication of articles is not only focused on integrating cultural values and mathematical concepts but also discusses reasoning, and students' mathematical communication skills, alongside educational media. The research by Kusuma (2019) compared the mathematical communication skills of students who received contextual education based on ethnomathematics and the implementation of the Mozart effect with those who acquired direct education. Likewise, there is an increase in the mathematical reasoning abilities and creative thinking skills realized through problem-based learning ethnomathematics-based (Amalia et al., 2021; Maidiyah et al., 2021). Implementing ARIAS (assurance, relevance, interest, assessment, satisfaction) education, aided by ethnomathematics, significantly affects the students' mathematical problem-solving skills (Aprilyani & Hakim, 2020). Some research developed ethnomathematical-based educational materials. These included Rohmaini et al. (2020), which showed that the ethnomathematical-based educational materials have appropriate or valid and interesting criteria to be used as learning resources in mathematics education.

Distribution of Ethnomathematical Research Areas in Indonesia

In 2018, the first Ethnomathematics Conference was held in Yogyakarta. However, in this research, the ethnomathematics association was built. Culture-based mathematics education needs to be further explored and studied because it includes contextual education. To

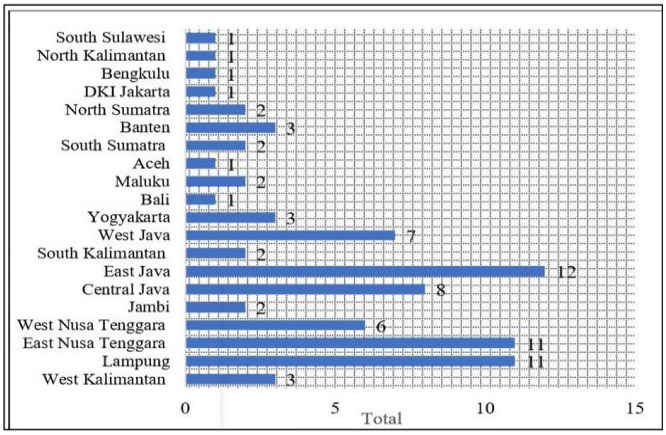

Figure 2. Distribution of ethnomathematical research areas throughout Indonesia (Source: Authors' own elaboration)

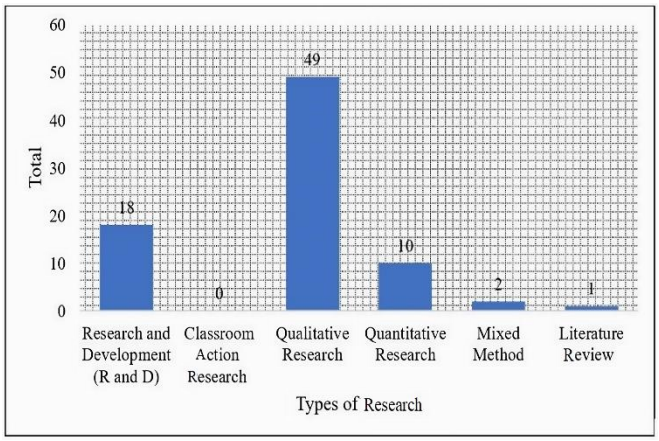

Figure 3. Distribution of ethnomathematical research as the main concern by type of research (Source: Authors' own elaboration)

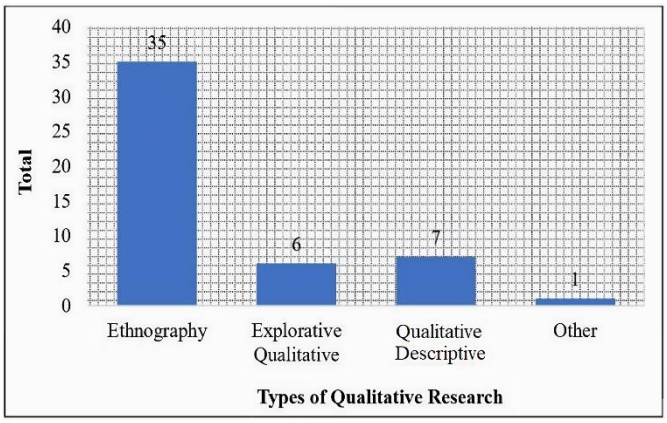

Figure 4. Distribution of qualitative research by type (Source: Authors' own elaboration)

some extent, local culture has not been able to find a place in the mathematics education curriculum. Its incorporation in mathematics education is more meaningful and increases love for one's homeland (Manik, 2020).

Innumerable research on ethnomathematics have been carried out in Indonesia. Several provinces are extremely productive in publishing articles related to ethnomathematical research, namely East and West Java, Nusa Tenggara, and Lampung. On the other hand, regions with few research publications are Aceh, South Sulawesi, and North Kalimantan. The distribution of ethnomathematical research in the country is shown in **Figure 2**.

Figure 2 shows that the province with the highest publication is East Java, with 12 articles, followed by East Nusa Tenggara and Lampung, with 11 each. In contrast, the regions with the least number of publications were South Sulawesi, North Kalimantan, Bengkulu, Jakarta, Bali, and Aceh, each with one article.

The publication of articles in each province mainly discusses cultural exploration as a source of learning mathematics, the elements contained in its values, and delivering this subject from a cultural perspective. For example, ethnomathematics of Sasak culture practiced in West Nusa Tenggara included reviews of traditional building architecture, games and dishes, woven fabric crafts, cultivation of cultural personalities, musical instrument, and pottery crafts. In South Kalimantan, exploratory research was carried out on cultural ethnomathematics in wetland areas to improve students' higher-order thinking skills (Fajriah et al., 2021). Furthermore, in Banyuwangi, East Java, a similar research was carried out in the main building of the English dormitory as an educational medium (Hasanah et al., 2019). A traditional game of engklek and marbles was played by the residents of West Java (Febriyanti et al., 2018, 2019), traditional dance movements in East Nusa Tenggara (Naja et al., 2021), and traditional music equipment from East Java (Hidayatulloh & Hariastuti, 2018).

Research Type

The qualitative method was used to determine the research type needed to investigate ethnomathematics in Indonesia, as shown in **Figure 3**. This type of research is superior and consistently aligns with some earlier analyses because it is relatively new in the world of learning (Sharma, 2013), which has been facing continuous increases in many institutions over the past few decades (Mohajan & Haradhan, 2018). Sharma (2013) reported that one advantage of this method is that it can record a detailed description of the participants' attitudes in small groups. However, the trend of tested qualitative design has increased (Shakouri, 2014) and is targeted at social research.

Figure 3 shows that out of 80 ethnomathematical research articles, no one used this type of classroom action analysis. The literature review included one article, two mixed methods, 10 quantitative, and 18 development research articles. However, the most dominant is qualitative research, with 49 articles.

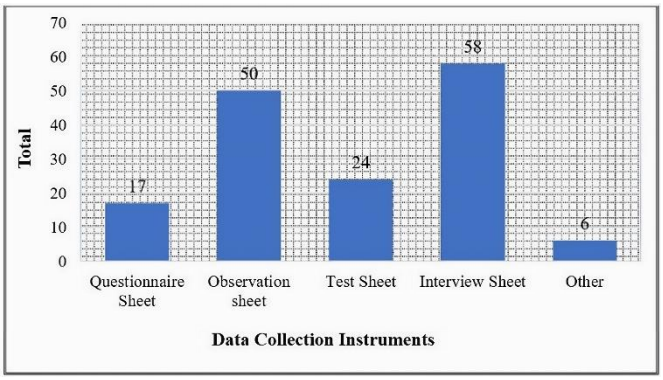

Figure 5. Instruments used in ethnomathematical research (Source: Authors' own elaboration)

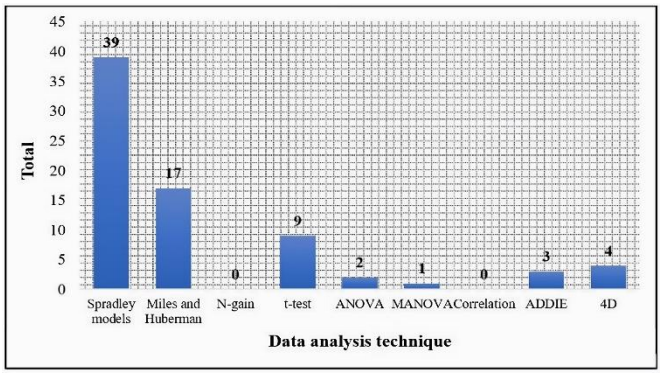

Figure 6. Data analysis techniques for ethnomathematical research (Source: Authors' own elaboration)

The 49 qualitative research articles were further differentiated according to the types, as shown in **Figure 4**.

Most ethnomathematical research carried out in Indonesia employed a qualitative method. There are 35 ethnographic research, seven qualitative descriptive, and six exploratory articles, while the rest remains unidentified.

Ethnography is the description of the culture, and its main objective is to understand life from the indigenous people's viewpoint (Sukadari et al., 2015). According to Spradley (1979), the main essence is to pay attention to actions from events that befell a particular group of people. Ethnography has distinctive characteristics such as the absolute involvement of scientific analyses, exploring the culture of the community, and requiring in-depth data exposure. This is in line with the research carried out by Marvasti (2004) in a work entitled "*Qualitative research in sociology*". It emphasized three ethnographic dimensions, namely the involvement and participation in the topic being studied, attention to the social context of data collection, and sensitivity to how the research subject is represented.

Research Instruments

The research instruments included validation sheets for experts, observation sheets, interviews, validation questionnaires, students' response sheets, observation sheets on the implementation of teaching materials, learning outcomes test questions, documentation, students' response questionnaires, literature research, observation guidelines, cultural context problem-solving test questions, validation sheets for textbooks or ethnomathematical material, learning motivation questionnaires, mathematical reasoning ability tests, and field notes, as shown in **Figure 5**.

These instruments are necessary for collecting data. According to the graph in **Figure 5**, the most widely utilized tool for data collection is tests, followed by interviews using 58, 50, and 24 sheet instrument. At least 17 questionnaire sheets and the remaining six articles were not identified.

Data Analysis Techniques

The data analysis techniques were carried out through (1). Description and presentation. The data source triangulation procedure was conducted by comprehensively exploring the relationship between mathematical knowledge systems and culture. This also includes investigating the mathematical conceptions in culture analyzed by adopting the steps proposed by Creswell and ethnographic methods (2). The data analysis techniques use the Miles and Huberman model for data reduction, data presentation, conclusion, and verification (3). ADDIE model product development analysis, and acronym, which stands for (A) analysis, (D) design, (D) development, (I) implementation, and (E) evaluation (4). The research on the development of 4D models, namely defining, designing, developing, and disseminating (5). Descriptive and inferential analyses, test (normality and homogeneity), hypothesis evaluation (t-test, multivariate), and MANOVA (6). Taxonomic analysis (7). Normality test using one-sample Kolmogorov Smirnov, homogeneity of variance test using the Levene statistical, and one-way ANOVA tests (8). Data analysis employed an ethnographic approach proposed by Spradley (1979), namely domain and taxonomic analyses (10). Quasi-experimental design (11). Analysis using one-way variance (one-way ANOVA) to test the hypothesis. This procedure is also used to test an experiment's average or treatment effect using one factor, which has three or more levels. Based on the aforementioned description, the data analysis techniques in ethnomathematical research are summarized as shown in **Figure 6**.

In **Figure 6**, Spradley (1979) model of information analysis method is widely used in ethnomathematical research, as detected in 39 articles. The descriptive qualitative model of Miles and Huberman has 17 articles, and experimental research using t-tests comprised nine. Meanwhile, ADDIE model development research has three, 4D model development comprises four, while ANOVA and MANOVA both have two and one article, respectively.

In **Figure 6**, it appears that none of the ethnomathematical research used correlation and n-gain analyses, therefore, these can be used as follow-up evaluation. Information analysis of Spradley (1979) model is widely used because this qualitative approach aims to describe culture as a whole. This includes all aspects, such as artifacts, tools, clothes, buildings, etc., and non-material, namely beliefs, norms, and value systems of the group under investigation.

Mulyana (2006) stated that thick description is the main characteristic of ethnography. Three forms of qualitative ethnographic research information are provided on the Spreadly model used to find cultural themes. These include domain, taxonomic, componential, and cultural theme analyses (Sugiyono, 2014). The ethnographic approach shares detailed field research-based analysis and description of the culture under investigation. Mathematical activities in relation to a particular culture can be described as an application of instructional content in schools based on in-depth examination and description. This approach is ideal for ethnomathematical research, which entails examining culture to develop mathematical factors or notions.

Indonesian Research Participants in Ethnomathematics

Based on 80 articles from 27 journals, there are two main categories of ethnomathematical research topics, those related to investigating the presence of mathematical concepts or activities in culture and subjects at the educational unit level to develop or apply ethnomathematical teaching materials. First, students in elementary, junior, and senior high schools, including universities, constitute the subjects at the educational unit level. Second, the general public, a group of people from a particular tribe or area of origin, community leaders, and those connected to the topic are regarded as the subject of ethnomathematical research on culture. **Figure 7** shows the ethnomathematical research topic based on the information that is currently accessible.

Figure 7 shows that more than 50% of the research participants are citizens, while the majority of the subjects at the learning unit level are in Junior High School. The subjects at the junior, elementary, senior high school, and college levels, have 17, nine, three, and eight articles, respectively. Research on the creation of instructional materials related to ethnomathematics and LKPD is still low. This is also in line with Hidayati and Prahmana (2022) who stated the need to conduct it in secondary schools and universities. The domination of subjects is 23 articles on universal citizens, 15 on craftsmen and businessmen, and four on cultural actors, as shown in **Figure 7**.

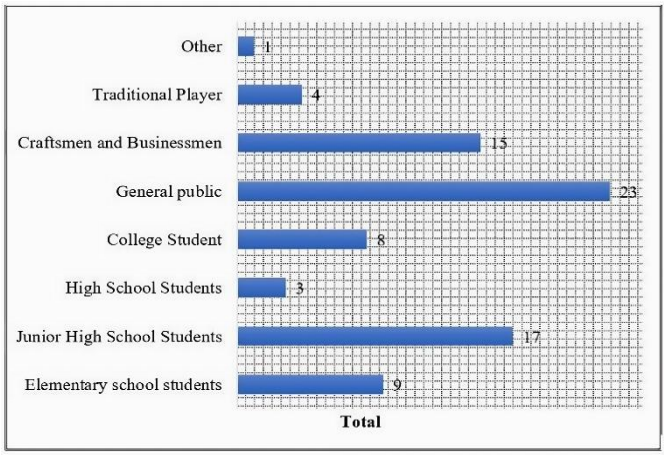

Figure 7. Subject of ethnomathematics research article in Indonesia (Source: Authors' own elaboration)

Ethnomathematical Research Discussion Material

Mathematics has much material that needs to be examined, but this is frequently considered challenging for students. Incorporating contextual, cultural factors, ethnomathematics, produces meaningful and relevant education for pupils. Culture can be used as a context in the process of learning mathematics. This offers several benefits, namely concept generation, access, and motivation to mathematics, modeling, providing intellectual tools using procedures, notation, images, and rules, as well as reality as a source of the application domain, and enhancing specific skills in certain situations (Lisnani et al., 2020; van den Heuvel-Panhuizen, 1996). Mathematics is essentially developed from expertise or cultural activities, and persons' capability is influenced by their background (Bishop, 1994).

The mathematical materials and elements discussed in ethnomathematical research are quite diverse. Based on several reviews, the information acquired is fairly diversified, including 80 publications in 27 journals, etc. These include plane, space and transformation geometry (reflection, rotation, shift, dilation), number patterns and operations, linear equations one, two, and three variables, mathematical statistics, measurement, field analytical geometry, linear programming, permutations, combinations and probability, mathematical logic, congruence, similarity, symmetry and scale, time and, temperature conversions, sets, Pythagorean theorem, comparison, and fraction concepts, arithmetic sequences and series, construct flat and curved side spaces, social arithmetic, graph theory, common multiples, LCM and GCF, rotary body volume and function graph.

Meanwhile, the grouping of material in the ethnomathematics journal is shown in **Figure 8**.

Figure 8 shows that the mathematical materials and elements widely discussed in ethnomathematical research are flat plane and spatial geometry, reviewed by as many as 46 articles. Furthermore, 17 of these

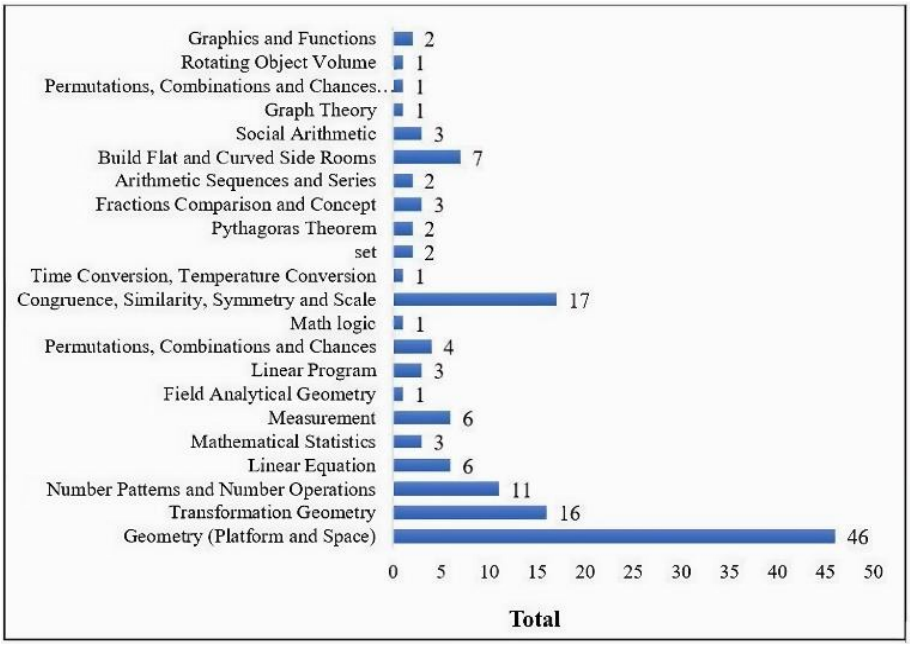

Figure 8. Ethnomathematical research discussion topics (Source: Authors' own elaboration)

articles contained congruence, similarity, symmetry, and scale, with transformation geometry analyzed 16, while the rest had an average of one to six articles. Geometric materials are connected with the employment of mathematical principles in the setting of traditional homes or cultural heritage structures, archaeological sites, batik motifs, traditional games, musical instrument, dances, food, and pottery crafts.

DISCUSSION

The findings in this research showed that students who receive instructions based on an ethnomathematical perspective have greater memory and average achievement score than those taught with the conventional approach. This is also in line with Sunzuma and Maharaj (2019) that the ethnomathematical approach has been proven feasible in promoting meaningful education.

Previous research proved that students are happy and intrigued by using ethnomathematics in education (Verner et al., 2013). This approach helps to improve citizens higher-order thinking abilities and self-awareness, thereby making issues more approachable (Budi Utami et al., 2019; Fouze & Amit, 2018b). Mania and Alam (2021) concluded that ethnomathematics is enjoyable, worthwhile, and clearer in students' minds. They can prepare traditional meals and play games daily, and teachers use these as mathematics education media. This research mainly created positive perceptions of tutors about the ethnomathematical approach.

Achor et al. (2009), Adam (2004), D'Ambrosio (2001), Gerdes (2011), Rosa and Orey (2010), and Zhang and Zhang (2010) emphasized the innumerable benefits of the ethnomathematical approach in learning mathematics. For example, when integrated into geometry, it simplifies the teaching procedure, improves students' retention and attainment, makes it more relevant and significant for them, as well as enhances the quality of education (Madusise, 2015).

Based on the analysis of ethnomathematical research in Indonesia, many facts in the literature supported the claim that culture is applicable in mathematics classes with various learning resources. Hwan (2000) suggested two methods for integrating ethnomathematics into teaching and learning. First is the use of inventive ideas motivated by one's culture, and the exploration of new ideas. Second is the role played by ethnomathematical materials in the process of enculturation and acculturation within and across various customs. In the past three decades, ethnomathematics has become widely discussed worldwide, including Indonesia. The three most discussed topics in the country are geometry with 46 articles, congruence, similarity, symmetry, and scale with 17, and transformation geometry with 16.

Ethnomathematics is a methodology for continually examining the transmission processes, disseminating and institutionalizing mathematics as knowledge derived from various cultural contexts throughout history (D'Ambrosio & Rosa, 2016). The main challenge is the integration of this approach in classroom teaching. However, certain barriers are encountered, such as teachers' competence in managing classes, teaching experience, and professionalism, and refusal to change the educational paradigm, which requires substantive descriptions related to various aspects of ethnomathematical training (Sunzuma & Maharaj, 2019).

In accordance with a research of 80 ethnomathematical articles and 27 journals, this present research formulated six measures, namely cognitive,

conceptual, learning, epistemological, historical, and political dimensions. These are interrelated and aim to analyze the sociocultural basis of mathematical knowledge (D'Ambrosio & Rosa, 2016). The mapping of ethnomathematical research trend with respect to the dimensions stated by D' Ambrosio (2001) is:

(1) **Cognitive measure:** This focuses on the generational acquisition, consolidation, and transfer of mathematical knowledge. It includes comparison, categorization, quantification, measurement, generalization, modeling, and other mathematical concepts assessment recognized as anthropological, social, and cultural phenomena that stimulate the knowledge systems of different cultural groups.

(2) **Conceptual measures:** Various cases encountered daily share the same space with cultural communities resulting in mathematical procedures and applications based on the representation of reality. This concept focuses on the development of essential knowledge and is some form of reaction to the challenges experienced during natural selection. In addition, it also triggers and ensures the continued existence of mathematical inspiration.

(3) **Learning size:** Ethnomathematics does not eliminate the fact that knowledge of mathematics is perceived as the highest achievement of humans (Adam et al., 2003). In terms of learning, this approach combines the principles of knowledge and academic attitudes with human values such as respect, tolerance, acceptance, concern, dignity, integrity, and peace and incorporates them into daily context.

(4) **Epistemological measure:** This relates to the system of knowledge, which is a collection of empirical observations raised to control, explain, and deal with reality. But three problems related to evolution of mathematical knowledge concerning various forms of dissemination emerge, generation, and organization including

   (a) the method of transferring knowledge obtained through observation to experimental application,

   (b) the shifting from experiment to reflection and abstractions, and

   (c) methods of representing findings in proposing a theory.

(5) **Historical measure:** The bond between history and mathematics is a reality that students must understand. This measure ensures they are focused on studying the nature of this subject in terms of describing how mathematical knowledge is expressed according to their diverse experiences.

(6) **Political measure:** This aims to identify and honor the history, traditions, and mathematical ideas raised by members of a cultural group. This recognition and respect for sociocultural roots does not imply a rejection of other people's cultural bases but strengthens them through dynamic cultural discussions.

In Indonesia, research on ethnomathematics is also widely found, specifically in learning mathematics. Some tend to focus on this approach, including the development of students worksheets based on Timor ethnomathematics on number pattern material (Disnawati & Nahak, 2019), intermediate field in solving ethnomathematical problems (Ulya & Rahayu, 2020), ethnomathematical studies of Keraton Batik patterns Surakarta through symmetry analysis (Astriandini & Kristanto, 2021), ethnomathematics exploration of Sukapura Batik (Mulyani & Natalliasari, 2020). The influence of assurance education, relevance, interest, and assessment had an impact on solving problems related to ethnomathematics (Aprilyani & Hakim, 2020).

CONCLUSION

The number of ethnomathematical research publications in Indonesia since 2019 has increased compared to previous years, and the highest number was recorded in 2021. The pattern of more related articles being published showed an increase in significant research and the eagerness to investigate this approach in Indonesia. The distribution of provinces as the object of ethnomathematical research is mostly carried out in East Java, and Nusa Tenggara, alongside Lampung.

The completed ethnographic qualitative design is widely used by ethnomathematical research in Indonesia. On the other hand, Spradley (1979) model of information analysis (ethnography) is often employed, following the descriptive qualitative analysis of the Miles and Huberman model, experimental research using the t-test, as well as evaluation of the developed ADDIE model. Resources and mathematical elements that are frequently discussed are flat plane and spatial geometry, followed by congruence, similarity, symmetry and scale, and transformation geometry. These materials relate to classic homes or cultural heritage structures, archaeological webs, Batik motifs, traditional games, music and dance equipment, food, weaving, and pottery crafts.

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