Making the Association between Culture and Mathematics Education

Nadide Yılmaz
Karamanoğlu Mehmetbey University

Culture and Mathematics

Mathematics was created by people to explain daily life and to help find solutions to problems that arise in social, cultural and natural environments (D'Ambrosio, 2001). In this process, as the interaction between people increased, mathematical knowledge between different cultures was affected by each other (D'Ambrosio, 1985). As a matter of fact, the existence of this interaction is noteworthy in the process of emergence of mathematical discoveries. For example, while the Maya invented the number zero and positional value attributed to Hindus in the 9th century (Rosa & Orey, 2005), these concepts were transferred from Hindus to Arabs through exchanges and commercial activities. Besides, the most well-known quantification is based on the Hindu-Arabic number system, which originates from a historical relationship between two different cultural groups that developed their own mathematical knowledge bases (Rosa & Gavarrete, 2017). As indicated in the examples, when the history of mathematics is examined, it is seen that mathematics is in direct interaction with culture, and that mathematics explored by different cultural groups has become valuable in this context (Nasir & Cobb, 2007, Rosa & Orey, 2011). People have developed mathematical concepts by passing through reasoning processes such as quantification and measurement on the basis of their cultural values and traditions in order to solve real life problems (Rosa & Orey 2010; Sunzuma & Maharaj, 2020). Researchers working on this subject point out the importance and necessity of addressing mathematics within the cultural context (Ascher, 2005; Küçük, 2013; Rosa & Orey, 2011).

While Bishop (1994) sees mathematics as a form of culture, Madusise (2015) states that mathematics is a subset of indigenous knowledge. This emphasis has shown itself in school mathematics as well, and it has been advocated that the process of learning-teaching mathematics should be structured in connection with culture (Bishop, Hart, Lerman, & Nunes, 1993; Seah & Bishop, 2003). Therefore, teaching mathematics cannot be separated from students' historical background, social context and world view (Gwekwerere, 2016) because learning becomes more meaningful when the teaching process is related to culture. Contextual learning environments related to culture make learning interesting and fun for children, especially in learning mathematics (Peni, 2019) because the learned mathematical concepts turn into activities that students can use in solving daily problems (Gravemeijer & Terwel, 2000). Mathematics teachers should pay attention to linking students' basic knowledge, cultures and histories with

mathematics while structuring learning processes. The importance of this link should be emphasized in the training given to pre-service teachers who will be the teachers of the future, and it is emphasized that pre-service teachers should gain knowledge and skills about how to develop and integrate the relationship between culture and mathematics into learning environments (Harding-DeKam, 2007; Sharp, 1999; Supriadi, 2019). The inclusion of diverse ideas from people from different cultural contexts into the teaching-learning process allows students to see different perspectives in the process of learning mathematics (Rosa & Orey 2015). In addition, attention is drawn to the positive contribution of associating the mathematics learning process of students with low academic performance in mathematics with culture (D'Ambrosio, 2001). The benefits of this constant interaction between mathematics and culture paved the way for the emergence of the concept of ethnomathematics (D'Ambrosio, 2001; Fitroh & Himawati, 2015; Orey & Rosa, 2006).

Ethnomathematics

Although ethnomathematics began as "the study of the mathematical ideas of illiterate people" (Ascher & Ascher, 1986) in the 1980s, it has expanded into indigenous communities and cultures and a wide variety of professions (e.g. carpenters) over time (Barton, 2008; Costa & Silva, 2010; Knijnik, 1999; Masingila, 1994; Palhares, 2008; Shockey, 2002). According to Fitroh and Himawati (2015), ethnomathematics is culture-based or culture-influenced mathematics. When the etymology of ethnomathematics is examined, it is seen that "ethno" represents sociocultural contexts including language, jargon, symbols and behaviours, while "mathema" indicates activities such as measuring, classification, sequencing, interpretation, justification, understanding and knowing and "tics" comes from the same root as the words art and technique (D'Ambrosio, 1985). Ethnomathematics is defined as "the mathematics practiced by cultural groups, such as urban and rural communities, groups of workers, professional classes, children in a given age group, indigenous societies, and so many other groups that are identified by the objectives and traditions common to these groups." (D'Ambrosio, 2001, p.1). It is also a field of study that combines the history of mathematics, anthropology, pedagogy, linguistics and mathematics philosophy with a variety of pedagogical applications, as well as that focuses on explaining and understanding different sociocultural environments. It examines how different groups of people understand, express, process and use mathematical ideas, procedures and practices to solve problems related to their daily lives. In addition to presenting an innovative theoretical basis consisting of philosophical, political and epistemological dimensions of the development of mathematical knowledge, understanding human behaviour by making sense of the mathematical ideas and procedures applied by humanity can be described as another goal of ethnomathematics (D'Ambrosio, 1988, 1997; Rosa & Gavarrete, 2017). At this point,

it can be said that ethnomathematics embraces mathematical ideas, thoughts, concepts and applications developed by different cultures as well as modern mathematics and science (Barton 1996; D'Ambrosio 1985; Frade, Acioly-Régnier, & Jun, 2013).

Ethnomathematics approach is based on social constructivism (Brandt & Chernoff, 2015; Laridon, Mosimege, & Mogari, 2005; Sunzuma & Maharaj, 2020) because in this research area, there is problem solving and situating learning in a real life context enriched with manipulative and interactive materials. In addition, it is aimed for individuals to discover new cultural experiences based on their previous experiences (Kurumeh, Onah, & Mohammed, 2012).

Ethnomathematics research has also focused on understanding the mathematical applications of different cultural groups and supporting the development of the world in a more just and equitable way by finding solutions to various problems (e.g. economic, environmental) (Bishop, 2004; D'Ambrosio, 2010; Wedege, 2010). Studies on the mathematics of different cultures reveal the need to investigate many components that affect this. For example, language is one of these components. Detailed examination of the language (e.g. grammar, signs) allows a deep understanding of the culture of that language (Meaney, Fairhall, & Trinick, 2008; Mosimege, 2017; Rosa & Gavarrete, 2017). Therefore, it is important for researchers to become familiar with local languages in order to access different forms of expression associated with the mathematical knowledge of other cultures (Mosimege, 2017; Rosa & Gavarrete, 2017). In addition to language, art and architecture, clothing types, food and tools that different cultural groups use to understand and explain their social, cultural and historical contexts embody the hidden mathematics (Alangui & Rosa 2016; Rosa, 2005; Rosa & Gavarrete, 2017; Rosa & Orey 2012). The mathematical concepts used in cultural works form part of the numerical relationships involved in measurement, calculation, games, divination, navigation, astronomy and modelling (Eglash, Bennett, O'Donnell, Jennings, & Cintorino, 2006).

Rosa and Orey (2015) argue that ethnomathematics is a body of knowledge built by members of different cultural groups over time and through generations in close contact with their historical, social, cultural and natural environment. It is pointed out that through ethnomathematics, mathematics will be understood as a social science that contributes to the sociocultural development of communities, the production and enrichment of knowledge, and the development of dialogue between academia and society. This approach fosters cultural autonomy and idiosyncrasy to promote respect for diversity, as it perceives mathematics as a social phenomenon and a human activity (Rosa & Gavarrete, 2017). This integrates mathematical practices that have historically been developed in different cultures (Massarwe, Verner, & Bshouty, 2010). It takes mathematics out of the institutional learning context such as schools and universities and places it in people's inner world, culture and daily activities (Bishop, 1994; Brandt & Chernoff, 2015).

Bishop (1991), one of the pioneering researchers in the field of ethnomathematics, focused on how different cultures make sense of mathematics and proposed specific activities and examined these activities by classifying them in the context of mathematics to make comparisons between cultures. These activities are expressed as counting, locating, measuring, designing, playing and explaining. Sub-activities including these activities are indicated in Table 1.

Table 1. Bishop's (1991) 6 Activities and Sub-Activities Done by Cultures

Counting	Locating	Measuring	Designing	Playing	Explaining
Quantifiers (each, some, many, none)	Prepositions	Comparative quantifiers	Design	Games	Similarities
Adjectival number names Finger and body counting	Route descriptions	(faster, thinner)	Abstraction Shape	Fun Puzzles	Classifications
Tallying Numbers	Environmental locations	Ordering	Form Aesthetics	Paradoxes	Conventions
Place value Zero Base	Compass bearings	Qualities	Objects compared by properties of form	Modelling	Hierarchical classifying of objects
10 Operations on numbers	Up/down Left/ right Forwards	Development of units (heavy heaviest-weight)	Large, small	Imagined reality	Story explanations
Combinatorics	Backwards		Similarity	Rule-bound activity	Logical connectives
Accuracy	Journeys (distance)		Congruence	Hypothetical reasoning	Linguistic explanations:
Approximation Errors	Straight and curved lines	Accuracy of units Estimation	Properties of shapes Common geometric shapes, figures and solids	Procedures Plans	Logical arguments
Fractions Decimals	Angle as turning Rotations	Length		Strategies	Proofs
Positives, Negatives	Systems of location: Polar coordinates	Area		Cooperative games	Symbolic explanations:
Infinitely large, small		Volume		Competitive games	Equation Inequality
Limit		Time	Nets		Algorithm Function
Number patterns	2D/3D coordinates	Temperature	Surfaces	Solitaire games	Figural explanations:
Powers Number relationships Arrow diagrams		Weight	Tesselations	Chance, prediction	Graphs Diagrams
Algebraic representation	Mapping	Conventional units	Symmetry		Charts
Events Probabilities	Latitude/longitude	Standard Units	Proportion Ratio		Matrices
Frequency representations	Loci Linkages	System of units (metric)	Scale-model		Mathematical modelling
	Circle Ellipse	Money	Enlargements		Criteria: internal validity, external generalisability
	Vector Spiral	Compound units	Rigidity of shapes		

While counting includes activities and sub-activities used to compare and sort out events, locating focuses on spatial relationships and aims to explore these relationships through various forms of representation (e.g. model, diagram, drawing). Measuring includes measuring by using measurement tools, starting from the purposes of comparison and sequencing. Designing includes visualizing a product/object. While playing includes developing and dealing with games and entertainment, explaining is about establishing relationships and making logical explanations based on the situations encountered.

Ethnomathematics and Mathematics Education

With the globalization in education as in everything else in the world, it has become clear that traditional mathematics education approaches need various revisions because the traditional mathematics education curriculum often ignores the contributions of members of colonized and non-dominant cultures to mathematics. This causes limited consideration of how different cultures contribute to various mathematical activities (e.g. comparison, measurement, inference) in school mathematics, in other words, ethnomathematics cannot find a place at the desired level in the curriculum (Peni, 2019; Rosa & Gavarrete, 2017). However, ethnomathematics can support better structuring of mathematics teaching

as a bridge between culture and education (D'Ambrosio, 1989; Verner, Massarwe, & Bshouty, 2013; Widada, Sunardi, Herawaty, Boby, & Syefriani, 2018). Ernest's (2010) emphasis that mathematics is a cultural product allows the interpretation that this connection between mathematics and culture can be enriched through ethnomathematics in the process of teaching and learning mathematics (D'Ambrosio, 2001; Ernest, 2010) because ethnomathematics acknowledges that mathematical techniques, methods and explanations have been developed that allow different cultures to develop alternative understandings and social transformations to contribute to the process of achieving the targeted level of social justice, peace and respect (Rosa & Gavarrete, 2017). This contributes to the perception of school mathematics by students as "encouraging them to discover the mathematics of their own culture" (Gilmer, 1990).

Presence of mathematics in every field of life means that it is experienced by each culture and this makes its inclusion into the school mathematics curriculum compulsory (Brandt & Chernoff, 2015). In learning environments designed with an ethnomathematical approach, mathematical concepts are focused on through realistic activities and learning individuals are put into the centre (Mogari, 2014). Students can better understand the impact of culture on mathematics by valuing diversity in these types of math classrooms (Sunzuma & Maharaj, 2020). Using cultural contexts while structuring the teaching process supports students to see mathematics as a part of daily life, which helps them establish mathematical connections (La Ferla, Olkun, Gönülateş, & Alibeyoğlu, 2008). In addition, the use of works belonging to various cultures in teaching environments increases students' self-confidence and improves their creativity and encourages them to discover complex mathematical ideas and applications (D'Ambrosio 2006; Eglash, et. al., 2006; Orey 2000; Rosa & Orey 2015). Ethnomathematics has made significant contributions to learning and teaching of mathematics in traditional classrooms, especially to cultural roots, interactions between mathematics and languages, human interactions and values and beliefs (Bishop, 2002; 2010). However, it was noticed that ethnomathematics studies in learning environments were not at the desired level (D'Ambrosio, 2010a; Frade, et. al., 2013). The reasons for this are the high number of students' needs, the difficulty of creating teaching programs in the complexity of traditional classrooms, and anxiety about completing central exams and curriculum on time (D'Ambrosio, 2010b; Frade et al., 2013; Yolcu, 2019). However, one of the most important reasons for teaching mathematics is to make students aware that mathematics is an integral part of humanity's cultural heritage and that it should be seen as a reflection of the culture and thoughts of societies (D'Ambrosio, 1995). According to Adam, Alangui, and Barton (2003), a child's mathematics education first begins in the culture he/she lives in. With the progressing process, universal mathematics is encountered. At this point, the interaction of culture with mathematics can make important contributions to the development of mathematical thinking in children. As a matter of fact, the most creative, dynamic and

productive societies take this emphasis into account in the educational and instructional process (Florida, 2004). For this reason, learning environments should be structured by considering the sociocultural contexts in line with the interests and needs of students, rather than just the application of procedures and formulas and curriculum activities free of context (Rosa & Gavarrete, 2017; Rosa & Orey, 2016; Vithal & Skovsmose, 1997).

Attention is drawn to the need to include cultural debates in mathematics curricula to help educators accept the relationship between cultural and school mathematics knowledge (Rosa & Gavarrete, 2016). If the process of teaching and learning mathematics is structured through cultural practices, students can gain the ability to relate the mathematics taught in the classroom to their natural environment (Sunzuma & Maharaj, 2020). The ethnomathematics approach covers all aspects of mathematics teaching and learning, consisting of the content and development of the curriculum to enhance teaching and learning (Aikpitanyi & Eraikhuemen, 2017). In addition, it is clear that ethnomathematics includes humanistic views such as respect for cultural diversity, equality and social justice and human rights in the classroom environment. Mathematics education researchers and teachers who agree with these views do not accept assumptions and claims based on the development of precise practices or any form of discrimination (Frade, et. al., 2013). The ethnomathematics perspective in mathematics education enables educators to rethink the nature of mathematics by seeing the perspectives of people from different cultures on mathematical ideas such as measurement, classification, regulation, inference, modelling (Rosa & Gavarrete, 2017).

Research shows that students who study with materials associated with ethnomathematics are more successful than those who do not and that their problem solving and critical thinking skills develop positively (Imswatama & Lukman, 2018; Supriadi, Suryadi, Sumarmo, Rakhmat, 2014). This reveals the importance of relating the materials to be used in the curriculum and teaching process to the culture (Peni, 2019). Other positive results were that students are more willing to be engaged in such activities and that they can evaluate mathematics from different perspectives (Meaney & Lange, 2013). Moreira (2007) suggests that a mathematics teacher should act as an ethnomathematics researcher. Rosa (2013) notes that it is important to understand both the culture and its connection with mathematics teaching, because teachers who are aware of this connection can design teaching practices to support the positive learning expectations of learners.

In general, it is thought that it is necessary to integrate ethnomathematics into every mathematics class because ethnomathematics supports students to develop their own understanding by making connections with what they have learned before. This also has the potential to help students feel accepted and be more accepting of others (Brandt & Chernoff, 2015). When the literature is reviewed, it can be said that the studies conducted are generally grouped under four headings. While some studies focus on how different

cultures perceive various mathematical concepts, some others focus on the effects of students' working on activities prepared according to the ethnomathematical perspective. It is noteworthy that there are few studies involving the awareness, knowledge and skills of teachers and pre-service teachers about ethnomathematics. In some studies, both teachers and students are evaluated together (Figure 1).

Figure 1. Classification of Studies on Ethnomathematics

It has been revealed that studies focusing on the mathematics of different cultures look at how they handle mathematics in tools such as languages, games, architectural works, agricultural tools, musical instruments used by cultures. Although studies emphasize many points, the common result that they all draw attention to is that there is mathematics in every tool used by cultures (Aktekin, 2017; D'Ambrosio, 2002; Fantinato, 2004; Küçük, 2014; Lipka & Andrew-Irhke, 2009; Pradhan, 2017; Septianawati, et. al., 2017; Sharma & Orey, 2017; Yusuf, et. al., 2010). These studies are presented below in detail.

D'Ambrosio (2002) focused on the relationship of wines brought to Southern Brazil by Italian immigrants with mathematics. Interviews were made with winemakers, and it was noticed that winemakers who made their own barrels found their barrel volume through a process very different from academic mathematics. It is stated that this application is a very good reflection of ethnomathematics because the producer learned the wine-making techniques from his/her father long before he/she came to Brazil, and these techniques have been handed down from generation to generation for centuries.

Fantinato (2004) shared the results of an ethnomathematics study conducted on a group of low-educated adults living in a poor neighbourhood of Rio de Janeiro. The study aimed to understand the quantitative and spatial representations created and used in different life contexts and the relationships between these representations and school mathematics

knowledge. The data obtained show that there is a strong relationship between the use of mathematical skills in daily life and survival strategies to meet basic needs such as managing a reduced budget. In addition, it has been observed that mathematics is also associated with emotional factors such as protecting one's identity. In addition, this study clarified the prevalence of social and economic factors that interfere with the creation, representation and use of mathematical knowledge in the urban context.

Lipka and Andrew-Irhke (2009) focused on how mathematics is culturally handled and carried out their study in Alaska. They brought mathematicians, mathematics educators, education researchers, teachers and adult people from the Yupik people of Alaska together and examined the mathematical knowledge that the Yupik people used in the process of producing parquets, which they called Yupik. In this process, it was concluded that the method used by one of the students to create the square, which is a geometric shape, included the use of the hand finger joint as the unit of length measurement, has a proof beyond the Euclidean geometry, that the student found the middle point of the square by folding this square into one-quarter to form smaller squares and used the transformation geometry while doing these.

Yusuf, et. al. (2010) examined the relationship between mathematics and the games played by people in the Hausa community living in Western Nigeria. In the study, it was determined that these games were shaped by the stories told and questions asked by the adults of the culture in order for children and young people in the Hausa culture to develop their thinking powers and minds and to learn lessons for them. As a result of the study, it was revealed that the games played in Hausa culture are related to important mathematical subjects such as algebra, set theory, trigonometry, coordinate plane, arithmetic and geometric sequences, sorting, classification, measurement, timing and weighing. However, in the interviews made with the participants at the beginning of the study, it was noted that they stated that they thought that they did not have mathematics in their culture and that they did not have any connections with mathematics other than the lessons given at school.

Küçük (2014) linked the architectural and engineering structures in Anatolian culture and the carpet and rug motifs created in this culture with geometry. The findings have shown that bridges built in Anatolian culture in previous centuries have paraboloid surfaces to ensure that they are resistant to natural disasters and to minimize the amount of oscillation they will make in the face of possible effects. In addition, it was observed that the fountains in Anatolian culture were built with a paraboloid surface in order to easily drink water.

Aktekin (2017) compiled 86 different cultural elements, which he chose from Anatolian culture, under a total of six headings: number systems, measurement units, architecture and engineering, art, mind games and agriculture, and analyzed them in an

ethnomathematical sense. The results obtained showed that the practices people have performed within the scope of their culture are directly related to the mathematical thoughts they have. This shows the relationship between mathematics and culture and the importance of ethnomathematics in this relationship.

Pradhan (2017) aimed to reveal the mathematical knowledge used in the production of wooden works owned by Chundara, one of the professional caste groups in Nepal. To this end, he conducted in-depth interviews and observed activities at the Chundara workplace. The teaching and learning activities of Chundara took place in a participatory and collaborative way with the help of more experienced people. It was revealed that mathematics was used while making wooden works.

Sharma and Orey (2017) focused on how dhol, a musical instrument made and played by members of the Rai cultural group in Nepal, can be made meaningful for students. The researchers discussed how the use of culturally contextualized mathematics in this musical instrument can help students explore the relationship between school mathematics and their culture.

Septianawati, et. al. (2017) conducted a study to determine the specific length, area and volume units used by the Kampung Naga community, a traditional community living in Indonesia and separated from other cultures with their unique lifestyles, and the equivalents of these units in the standard units. They revealed that the lengths were measured by a rope, one knot was tied on each unit on the rope where the length was measured, and the number of knots obtained gave the measure of the length to be measured. Another finding is that community-specific length measurement units are called jeungkal, deupa or sameter. Area measurement calculations are made by measuring the edges of the area to be measured in meters, and then transforming them into bata (tumbak), areu and bau units, which are their unique area measurement units. Volume measurements are mainly used in house construction. Since the houses are mostly made of wood, the volume of the wood to be used for parts such as columns and beams in the house is calculated by multiplying the length, width and thickness values of the wood. Élo, dim, strip and kibik are used as the units of volume measurement.

It can be said that studies conducted with pre-service teachers and teachers are relatively fewer. From among these few studies, the majority were conducted with pre-service teachers (Albanese & Gavarrete, 2015; Katsap & Silverman, 2008; Supriadi, 2020) and the number of such studies conducted on teachers is highly limited (Sunzuma & Maharaj, 2020). The results obtained revealed that ethnomathematics applications conducted with pre-service teachers had positive effects in various respects (Albanese & Gavarrete, 2015; Katsap & Silverman, 2008; Supriadi, 2020). Another remarkable finding is that teachers have awareness of the application of ethnomatics (Sunzuma & Maharaj, 2020). These studies are given below in more detail.

Katsap and Silverman (2008) researched the naturally occurring mathematics in the cultures of Jewish and Bedouin peoples, developed projects based on their discoveries and shared them in the classroom. In this process, the pre-service teachers shared their lesson plans and classroom activities in the classroom environment as well as the ethnomathematics activities obtained directly from their cultural experiences. The results obtained enabled the pre-service teachers to learn about their own culture and to start perceiving mathematical concepts as a mixture of two different understandings (academic mathematics and mathematics in the understanding of cultures).

Albanese and Gavarrete (2015) discussed two experiences in teacher education. Both of these experiences are based on ethnomathematics. The focus was on the way a group of folk dancers from Argentina and an indigenous people from Costa Rica construct geometric figures. Both of the experiences were observed to affect teacher education. In this way, it was emphasized that the reflection of mathematical knowledge and teaching practices in the curriculum in connection with the sociocultural environment fosters the creativity of pre-service teachers.

Supriadi (2020) collected the opinions of pre-service primary school teachers who were grouped on the basis of their educational background (science or non-science) and Sundanese language ability background (Sundanese language and non-Sundanese language) through questionnaires. The results revealed that the learning of ethnomathematics positively affected most of their tendency towards mathematical modelling.

Sunzuma and Maharaj (2020) aimed to understand teachers' awareness of ethnomathematics approaches and the applications of ethnomathematics that can be used in teaching and learning geometry. Data were collected through questionnaires and focus-group discussions. The findings showed that in-service teachers have different definitions of ethnomathematics approaches and are aware of the ethnogeometric practices found in their cultural practices and experiences that can be integrated into geometry teaching and learning.

It can be said that ethnomathematics studies have been mainly carried out on students. (Achor, et. al., 2009; Aktuna, 2013; Amit & Abu Qouder, 2017; Arismendi-Pardi, 2001; Gerdes, 2011; Imswatama & Lukman, 2018; Kara, 2009; Kørhsen & Misfeldt, 2015; Kurumeh, et. al., 2012; Lipka, et. al., 2005; Magallanes, 2003; Powell & Temple, 2001; Widada et. al., 2019). The results obtained, except for one study (Kara & Togrol, 2010), revealed that learning environments associated with ethnomathematics support the development of students in the following aspects.

- Make them realize that mathematics is more than numbers and formulas,

- Foster their achievement in academic mathematics,
- Make them individuals who can solve problems better and improve their critical thinking skills,
- Help them discover cultural thoughts such as self-control, competition, respect to other people, cooperation,
- Reveal the relationship between academic mathematics and cultural mathematics,
- Make them discover the existence of mathematics in tools such as games, architectural works, agriculture and language as well as professional and daily activities,
- Support the development of positive attitudes and self-confidence towards mathematics.

These studies are given in more detail below.

Powell and Temple (2001) investigated the process of playing a strategy game played on a board with pits on the board called Oware in Africa, known by different names in many cultures and played according to different rules adopted in different cultures by African American and Latin children living in America in both mathematical and cultural respects. In this process, it was observed that mathematical ideas such as inequality, estimation, number patterns emerged, as well as cultural ideas such as self-control, competition, respect for other people and cooperation.

Arismendi-Pardi (2001) compared the final exams of students who had been taught algebra with an ethnomathematical approach and those who had not. The results obtained showed that the students whose lessons were structured with the ethnomathematical approach were more successful than the students whose lessons were not structured with an ethnomathematical approach.

Magallanes (2003) focused on the subject of coordinate plane in his quasi-experimental study conducted on the students attending Torch Middle School in California. While the experimental group students were taught with activities associated with ethnomathematics, the control group students were taught with the traditional method. The results obtained showed that the experimental group students' achievement scores are significantly higher than those of the control group students. A very similar study was carried out with 248 Junior Secondary three students in Obi and Oju education areas of zone C in Benue state of Nigeria by Kurumeh, et. al. (2012) and similar results were obtained.

Lipka, et. al. (2005) conducted an application with the participation of local Yupik elders, teachers, schools and communities, and then an experimental study was conducted to

observe students' mathematical performance and changes after the application. The activities prepared focused on integrating daily knowledge into school mathematics. The findings revealed that the students discovered mathematical concepts in more depth while engaged in the activities. In addition, this teaching experiment that students participated in caused statistically significant differences in terms of improving their academic math performance. In addition, these activities were observed to support students in establishing the relationship between real life situations and mathematics.

Achor, et. al. (2009) conducted a quasi-experimental study with 253 students by designing learning environments with an ethnomathematical approach in Nigeria. The subject focused on in the study was the concept of trajectory in geometry and the experimental group students were thought with ethnomathematical approach and the control group students with the traditional approach. The results showed that the mean achievement score of the students taught with the ethnomathematical approach was approximately twice more than the score of those who were taught with the traditional approach. In addition, it was found that the mean retention score of the students taught with the ethnomathematical approach were approximately three times more than the score of those who were taught with the traditional approach.

Kara (2009) focused on students' achievements in and attitudes towards mathematics with a semi-experimental study. Lessons were designed in experimental groups with an ethnomathematical approach. A total of 137 middle school 7th grade students were included in the study, focusing on symmetry, pattern and the features of the structures in Topkapı Palace. The results revealed that while the mathematics achievement scores of the experimental and control groups of the participants in two of the three different middle schools are close to each other, there is a significant difference between the mathematics achievement scores of the experimental and control group students from the third school. In addition, although no significant difference was found between the attitude scores of the students from two middle schools, a statistically significant difference was found between the attitude scores of the experimental and control groups from the third school.

Gerdes (2011) used African Art to teach various concepts of geometry (e.g. area and circumference of the circle, symmetry and transformation), using handbag, hat, straw and basket tray decorations in Mozambique. Gerdes (2011) advocated their use in geometry teaching and learning in primary school settings. It was emphasized that the artistic ornaments in the works could be used while structuring the geometry learning-teaching process and that geometric concepts could be structured based on these ornaments. It was also pointed out that with the works used, geometry can become concrete for students.

Aktuna (2013) conducted a study with the children of families living in rural areas and earning their livelihood mostly with olives and a total of 12 6th graders participated in the

study. With the help of their cultures and real life situations, ethnomathematics activities were designed for the participants, and the students' perceptions and associations in relation to the measurement of an area were examined. The findings revealed that the mathematics performance of the students with medium and below-medium mathematics achievement increased significantly, while the mathematics performance of the students with high and low mathematics achievement did not change. In addition, the students' interest, self-confidence and motivation in mathematics increased, and a more peaceful and collaborative classroom environment was created.

Kørhsen and Misfeldt (2015) stated that Minecraft, a digital game, allows students to create their own worlds and try to survive in this world by encouraging them to use their creative thinking and imagination. Thus, it was stated that this game could be used in mathematics education and 7 students at the age of 10 were asked to play this game after school. The methods and strategies they followed while playing this game, the problems they encountered and the information they used to solve these problems and the solution processes they followed were examined by adopting an ethnomathematical perspective and ethnographic research method. The findings obtained showed that while playing this game, students performed all six basic activities that Bishop (1991) put forth.

Amit and Abu Qouder (2017) aimed to integrate ethnomathematics into the mathematics curriculum of Bedouin students and overcome the difficulties in the mathematical structures of their daily lives and traditional length and weight units. First of all, 35 Bedouin adults were interviewed and then, based on the data obtained from these interviews, a 30-hour 7^{th} grade unit was integrated into the ethnomathematical approach in two Bedouin schools. Experimental and control groups were constructed and then the unit was taught. The findings revealed that the experimental group students' self-perception and motivation improved. However, the results of the test administered immediately after the completion of the study showed that there is no significant difference between the achievements of the experimental and control groups. The study caused students to raise their awareness by changing their attitudes towards their own culture and the older generation of the tribe.

Imswatama and Lukman (2018) examined the effect of teaching materials prepared with an ethnomathematical perspective on mathematical problem solving skills and critical thinking of students. Only the posttest control design was used in the study. The results revealed that the mathematics teaching materials based on ethnomathematics was effective in developing problem solving skills and mathematical critical thinking of students. In addition, it was concluded that the materials used with an ethnomathematical perspective fostered students' effectiveness.

Widada, et. al. (2019) used pretest-posttest group design to examine how students'

ethnomathematics-based approach affects problem solving. The study conducted on high school students revealed that students are better problem solvers in problem solving environments integrated into ethnomathematics.

Kara and Togrol (2010) designed a teaching to which 6-hour ethnomathematics was integrated focusing on the subject of symmetry, reflection, and decorations in the 7th grade. Experimental and control groups were constructed and the designed teaching was conducted with the experimental group. The results revealed that there is no significant difference between the achievement scores of the experimental and control groups. With the results it presented, the current study is different from other studies.

In some studies, teachers and students were included as participants together (Adam, 2004; Massarwe, et. al., 2012; Shuaibu, 2014). The findings revealed that including ethnomathematics in the teaching process helped both teachers and students to be aware of the relationship between academic mathematics and cultural mathematics. These studies are given below in more detail.

Adam (2004) structured the application he carried out with 5th grade teachers and students in the Maldives with an ethnomathematical perspective. The study focused on the concepts of environment, area and volume. Teachers and students went to different places such as markets, carpentry and boat building sheds to explore the features of these concepts in more depth. It was noted in this process that both teachers and students were able to get to know cultural activities and experiences that exhibit measurement systems in Maldivian culture. They were able to establish the relationship between the cultural mathematics activities they had learned and school mathematics. It was also found that the students were satisfied with the integration of ethnomatics into this process.

Massarwe, et. al. (2012) prepared a project that would support middle school students and teachers to make connections between geometry and culture by involving them in well-established ethnomathematics activities in their own and other cultures. The results showed that the participants were not aware of the relationship between geometry and culture at the beginning of the process. After the project, it was observed that they developed a great deal of awareness about the relationship between geometry and culture.

Shuaibu (2014) aimed to determine the mathematical thinking levels of students studying in two different states of Nigeria (rural and urban) and examined the effects of their cultures on the development of students' mathematical thinking levels. The participants of the study were all the students attending secondary schools in Kano and Oyo states and their mathematics teachers. Different questionnaires were applied to teachers and students during the research process. The results showed that there is no significant difference between the mathematical thinking levels of the middle school students, that there are activities to develop mathematical thinking of the students in both of the

cultures and that the students living in the rural area have a higher level of mathematical thinking than the students living in the urban area.

Concluding Remarks

Although studies have revealed the contributions of ethnomathematical research to both mathematics and mathematics education, some researchers, philosophers and educators state that they have some doubts about the role of ethnomathematics in mathematics education (Rosa & Gavarrete, 2017). "Which culture(s) should be in the mathematics curriculum? How would we know whether or not the educators and students make the link between culture and mathematics? How can an ethnomathematical attitude help develop a critical and reflective understanding of the mathematics curriculum? (Rosa & Gavarrete, 2017 p.14)" and similar questions are waiting to be answered in the field of ethnomathematics. This indicates that there is a need for more research.

References

Achor, E. E., Imoko, B. I., & Uloko, S. E. (2009). Effect of ethnomathematics teaching approach on senior secondary students' achievement and retention in Locus. *Educational Research and Review, 4*(8), 385-390.

Adam, S. (2004). Ethnomathematical ideas in the curriculum. *Mathematics Education Research Journal*, *16*(2), 49–68.

Adam, S., Alangui, W., & Barton, B. A. (2003). Comment on Rowlands and Carson: "Where would formal academic mathematics stand in a curriculum informed by ethnomathematics? A critical reviw", *Educational Studies in Mathematics, 52*(3), 327-335.

Aikpitanyi, L. A., & Eraikhuemen, L. (2017). Mathematics teachers' use of ethnomathematics approach in mathematics teaching in Edo State. *Journal of Education and Practice*, *8*(4), 34–38.

Alangui, W. V., & Rosa, M. (2016). Role of ethnomathematics in mathematics education. In M. Rosa, U. D'Ambrosio, D. C. Orey, L. Shirley, W. V. Alangui, P. Palhares, & M. E. Gavarrete (Eds.), *Current and future perspectives of ethnomathematics as a program* (pp. 31–37). ICME13 Topical Surveys. London, England: Springer Open.

Aktekin, D. (2017). *Etnomatematik*. (Unpublished master thesis). Kocaeli Üniversitesi, Kocaeli.

Aktuna, H. E. (2013). *Sixth grade students' perceptions of and engagement in*

ethnomathematical tasks in the area measurement concept. (Unpublished master thesis) Middle East Technical University, Ankara.

Albanese, V. & Gavarrete, M. E. (2015). Teacher training through research in ethnomathematics. CERME 9 - *Ninth Congress of the European Society for Research in Mathematics Education* (pp.1665-1666). Prague, Czech Republic, Feb 2015.

Amit, M., & Abu Qouder, F. (2017). Weaving culture and mathematics in the classroom: the case of bedouin ethnomathematics. In Rosa, M., Shirley, L., Gavarrete, M., & Alangui, W. (Eds.). *Ethnomathematics and its Diverse Approaches for Mathematics Education* (pp. 23-50). ICME-13 Monographs. Springer, Cham.

Arismendi-Pardi, E. J. (2001). *Comparison of the final grades of students in intermediate algebra taught with and without an ethnomathematical pedagogy. The global perspective: Teaching, learning and student equity.* A presentation to the Center for the Study of Diversity in Teaching and Learning in Higher Education. Miami, Florida.

Ascher, M. (2005). *Etnomatematik: Matematik Dünyasına Çok Kültürlü Bir Bakış* (Çeviri: Ercan, B.), İstanbul: Okyanus Yayıncılık.

Ascher, M., & Ascher, R. (1986). Ethnomathematics. *History of Science, 14*, 125–144.

Barton, B. (1996). Making sense of ethnomathematics: Ethnomathematics is making sense. *Educational Studies in Mathematics, 31*(1–2), 201–233.

Barton, B. (2008). *The languages of mathematics*. New York, NY: Springer.

Bishop, A. J. (1991). *Mathematical enculturation: perspective on mathematics education*. Netherlands: Kluwer Academic Publishers.

Bishop, A. J. (1994). Cultural conflicts in mathematics education: Developing a research agenda. *For the Learning of Mathematics, 14*(2), 15–18.

Bishop, A. (2002). Mathematical acculturation, cultural conflicts, and transition. In G. De Abreu, A. J. Bishop, & N. C. Presmeg (Eds.), *Transitions between contexts of mathematical practices* (pp. 193–212). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Bishop, A. J. (2004, July). *Critical issues in researching cultural aspects of mathematics education*. Paper presented in Discussion Group 2, 10th International Congress on Mathematics Education, Copenhagen, Denmark. Retrieved from http://www.icme-organisers.dk/dg02/

Bishop, A. (2010). Directions and possibilities for research on mathematics and culture, in relation to mathematics education: A personal view. In M. M. F. Pinto & T. F. Kawasaki (Eds.), *Proceedings of the 34th Conference of the International Group for the Psychology of Mathematics Education* (Vol. 1, pp. 338–342). Belo Horizonte, Brazil: PME.

Bishop, A., J.; Hart, K., Lerman, S. & Nunes, T. (1993). Significant Influences On Children's learning of mathematics, *Science and Technology Education, 47,* 3-61.

Brandt, A., & Chernoff, E. J. (2015). The importance of ethnomathematics in the math class. *The Ohio Journal of School Mathematics*, *71*, 31–36.

Costa, W. G., & Silva, V. L. (2010). A desconstrução das narrativas e a reconstrução do currículo: a inclusão dos saberes matemáticos dos negros e dos índios brasileiros (Narrative deconstruction and curriculum reconstruction: The inclusion of Brazilian indians' and black people's mathematical knowledge). *Educar, 36*, 245–260.

D'Ambrosio, U. (1985). Ethnomathematics and its place in the history and pedagogy of mathematics. *For the Learning of Mathematics, 5*(1), 44–48.

D'Ambrosio, U. (1988). A research program in the history of ideas and in cognition. *International Study Group on Ethnomathematics (ISGEm) Newsletter*, *4*(1), 5-8.

D'Ambrosio, U. (1989). A research program and a course in the history of mathematics: Ethnomathematics, *Historia Mathematica, 16*, 285–288.

D'Ambrosio, U. (1995). Multiculturalism and mathematics education. *International Journal on Mathematics Science, and Technology Education, 26*(3), 337–346.

D'Ambrosio, U. (2001).What is ethnomathematics and how can it help children in schools? *Teaching Children Mathematics*, *7*(6), 308–310.

D' Ambrosio, U. (2002). *Teaching and learning with mathematical modeling*. São Paulo: Editora Contexto.

D'Ambrosio, U. (2006). *Ethnomathematics: Link between traditions and modernity.* Roterdam, The Netherlands: Sense Publishers.

D'Ambrosio, U. (2010a). Ethnomathematics: A response to the changing role of mathematics in society. *Philosophy of Mathematics Education Journal. Special issue on Critical Mathematics Education, Vol, 25.*

D'Ambrosio, U. (2001). What is ethnomathematics, and how can it help children in schools?. *Teaching children mathematics, 7*(6), 308-308. Retrieved from http://vello.sites.uol.com.br/what.htm .

Eglash, R., Bennett, A., O'Donnell, C., Jennings, S., & Cintorino, M. (2006). Culturally situated designed tools: Ethnocomputing from field site to classroom. *American Anthropologist, 108*(2), 347–362.

Ernest, P. (2010). Add it up: Why teach mathematics? *Professional Educator*, *9*(2), 44–47.

Fantinato, M. C. C. B. (2004). Contribuiçoes da etnomatematica na educaçao de jovens e adultos: algumas reflexoes iniciais. In. J. P. M. Ribeiro, M. C. S. Domite, & R. Ferrira, (Eds.) *Etnomatematica: papel, valor e significado* (pp. 171-184). Sao Paulo: Zouk.

Florida, R. (2004). *The rise of the creative class and how it is transforming work, leisure, community and everyday life*. New York, NY: Basic Books

Fitroh W & Himawati N. (2015). Identifikasi Pembelajaran Matematika dalam Tradisi Melemang di Kabupaten Kerinci Provinsi Jambi. *Prosiding Seminar Nasional Matematika dan Pendidikan matematika UMS 2015.*

Frade, C., Acioly-Régnier, N., & Jun, L. (2013). Beyond deficit models of learning mathematics: Socio-cultural directions for change and research. In M. A. K. Clements, A. Bishop, C. Keitel-Kreidt, J. Kilpatrick, & F. K.-S. Leung (Eds.), *Third international handbook of mathematics education* (pp. 101–144). New York, NY: Springer.

Gerdes, P. (2011). African basketry: Interweaving art and mathematics in Mozambique. In *Bridges Coimbra mathematics, music, art, architecture, culture conference proceedings* (pp. 9–16). Coimbra: Tessellations Publishing.

Gilmer, G. (1990). An ethnomath approach to curriculum development. *ISGEm Newsletter*, *5*(2), 4–5.

Gwekwerere, Y. (2016). Schooling and the African child: Bridging African epistemology and eurocentric physical sciences. In E. Shizha & G. Emeagwali (Eds.), *African indigenous knowledge and the sciences. Journeys into the past and present: Anti-colonial educational perspectives* (pp. 33–46). Rotterdam: SensePublishers.

Gravemeijer, K., & Terwel, J. (2000). Hans Freudenthal: a mathematician on didactics and curriculum theory. *Journal of curriculum studies, 32*(6), 777-796.

Harding-DeKam, J. L. (2007). Foundations in ethnomathematics for prospective elementary teachers. *Journal of Mathematics and Culture, 1*(2).

Imswatama, A & Lukman, H., S. (2018). The Effectiveness of Mathematics Teaching Material Based on Ethnomathematics. *International Journal of Trends in*

Mathematics Education Research, 1(1), 35-38.

Kara, M. (2009). *Effects of instructional design integrated with ethnomathematics: Attitudes and achievement.* (Unpublished master thesis). Boğaziçi University, İstanbul.

Kara, M., & Togrol, A. Y. (2010). Effects of instructional design integrated with ethnomathematics: Attitudes and achievement. In K. Gomez, L. Lyons, & J. Radinsky, (Eds.), *Learning in the Disciplines: Proceedings of the 9th International Conference of the Learning Sciences,* (Vol.1, pp. 730-735). Chicago, IL: International Society of the Learning Sciences.

Katsap, A. & Silverman, F. L. R. (2008). A case study of the role of ethnomathematics among teacher education students from highly diverse cultural backgrounds, *J. Math. Cult. 3*, 66-102.

Kørhsen, K. L., & Misfeldt, M. (2015). An ethnomathematical study of play in minecraft. *Nordic research in mathematics education: Norma, 14*, 205-214.Retrieved from https://helda.helsinki.fi/handle/10138/159388

Kurumeh, M. S., Onah, F. O., & Mohammed, A. S. (2012). Improving students' retention in junior secondary school statistics using ethno-mathematics teaching approach in Obi and Oju local government area of Benue State, Nigeria. *Greener Journal of Educational Research*, *2*(3), 54–62.

Küçük, A. (2014). Ethnomathematics in Anatolia-Turkey: Mathematical Thoughts in Multiculturalism. *Revista Latinoamericana de Etnomatemática, 7*(1), 171-184.

Knijnik, G. (1999). Ethnomathematics and the Brazilian landless people education. *Zentralblatt fur Didaktik der Mathematik, 31* (3), 188–194.

La Ferla, V. Olkun, S. Gönülateş, F. & Alibeyoğlu, M., A. (2008). *Multicultural look at mathematics*, 11th International Congress on Mathematical Education, Monterrey, Mexico, 6-13 July 2008.

Laridon, P. E. L.,Mosimege, M., &Mogari, D. (2005). Ethnomathematics in developmental curriculum research in South Africa. In C. Keitel, R. Vithal, & J. Adler (Eds.), *Handbook of research in mathematics education in South Africa* (pp. 133–160). HSRC Press.

Lipka, J., & Andrew-Ihrke, D. (2009). Ethnomathematics applied to classrooms in Alaska: Math in a cultural context. *NASGEm Newsletter*, *3*(1), 8-10.

Lipka, J., Hogan, M. P., Webster, J. P., Yanez, E., Adams, B., Clark, S., & Lacy, D.

(2005). Math in a cultural context: Two case studies of a successful culturally based math project. *Anthropology and Education Quarterly, 36(*4), 367-385.

Madusise, S. (2015). Cultural villages as contexts for mediating culture and mathematics education in the South African curriculum. *Revista Latinoamericana de Etnomatemática*, *8*(2), 11–31.

Magallanes, A.M. (2003). *Comparison of student test score in a coordinate plane unit using traditional classroom techniques versus traditional techniques coupled with an Ethnomathematics software at torch middle school.* Retrieved from ERIC database. (ED479958).

Masingila, J. O. (1994). Mathematics practice in carpet laying. *Anthropology & Education Quarterly, 25*(4), 430–462.

Massarwe, K., Verner, I., & Bshouty, D. (2010). An ethnomathematics exercise in analysing and constructing ornaments in a geometry class. *Journal of Mathematics and Culture, 5*(1), 1-20 .

Massarwe, K., Verner, I., & Bshouty, D. (2012). Ethnomathematics and multicultural education: Analysis and construction of geometric ornaments. *Journal of Mathematics and Culture*, *6*(1), 344–360.

Meaney, T., Fairhall, U., & Trinick, T. (2008). The role of language in ethnomathematics. *The Journal of Mathematics and Culture, 3*(1), 52–65.

Meaney, T. & Lange T. (2013). Learners in Transition Between Contexts. In M. A. K. Clements, A. Bishop, C. Keitel-Kreidt, J. Kilpatrick, & F. K.-S. Leung (Eds.), *Third international handbook of mathematics education* (pp. 169-201). New York, NY: Springer.

Mosimege, M. (2017). Listening to the Voices of the Knowledge Holders: The Role of Language in Ethnomathematical Research, In: Rosa M., Shirley L., Gavarrete M., Alangui W. (eds) *Ethnomathematics and its Diverse Approaches for Mathematics Education* (pp.51-68). ICME-13 Monographs. Springer, Cham.

Mogari, D. (2014). An in-service programme for introducing an ethnomathematical approach to mathematics teachers. *Africa Education Review*, *11*(3), 348–364.

Moreira, D. (2007). Filling the gap between global and local mathematics. In D. Pitta-Pantazi & G. Philippou (Eds.), *Proceedings of the Fifth Congress of the European Society for Research in Mathematics Education 22 – 26 February 2007, Larnaca, Cyprus,* (pp. 1587–1596). European Society for Research in Mathematics Education & Department of Education, University of Cyprus.

Nasir, N. S. & Cobb, P. (2007). *Equity In Students' Access to Significant Mathematical Ideas*, NY: Teachers College Press, New York.

Orey, D. C. (2000). The ethnomathematics of the Sioux tipi and cone. In H. Selin (Eds.), *Mathematics across culture: The history of non-western mathematics* (pp. 239–252). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Orey, D. C., & Rosa, M. (2006). Ethnomathematics: Cultural assertions and challenges towards pedagogical action. *The journal of Mathematics and Culture, 1*(1), 57-78.

Powell, A. B., & Frankenstein, M. (Eds.). (1997). *Ethnomathematics: Challenging Eurocentrism in mathematics education* (pp. 15-21). New York: SUNY Press

Palhares, P. (Ed.). (2008). *Etnomatemática—Um olhar sobre a diversidade cultural e a aprendizagem matemática [Ethnomathematics—A look at the cultural diversity and the mathematics learning]* . Vila Nova de Famalicão: Húmus.

Pradhan J. B. (2017) Mathematical Ideas in Chundara Culture: Unfolding a Nepalese Teaching and Learning System. In: Rosa M., Shirley L., Gavarrete M., Alangui W. (Eds.) *Ethnomathematics and its Diverse Approaches for Mathematics Education.* (pp.125-152). ICME-13 Monographs. Springer, Cham.

Peni, N.R. (2019). Development Framework of Ethnomathematics Curriculum through Realistic Mathematics Education Approach. *IOSR Journal of Research & Method in Education (IOSR-JRME), 9*(4), 16-24.

Powell, A. B., & Temple, O. L. (2001). Seeding ethnomathematics with oware: Sankofa. *Teaching children mathematics, 7*(6), 369-373.

Rosa, M. (2005). *The ethnomathematics of Bakairi Body Painting.* In NCTM Annual Meeting and Exposition: Embracing Mathematical Diversity. Anaheim, CA: NCTM.

Rosa, M. (2013). Accessing the perceptions of high school teachers about the influence of language and culture in themathematics learning of English language learners (ELLs) students. *Linguistics, Culture & Education*, *2*(1), 36–71.

Rosa, M., & Gavarrete, M. E. (2016). Polysemic interactions between ethnomathematics and culturally relevant pedagogy. In M. Rosa, U. D'Ambrosio, D. C. Orey, L. Shirley, W. V. Alangui, P. Palhares, & M. E. Gavarrete (Eds.). *Current and future perspectives of ethnomathematics as a program* (pp. 23–30). ICME13 Topical Surveys. London, England: Springer Open.

Rosa, M. & Gavarrete, M. E. (2017). An Ethnomathematics Overview: An Introduction,

In M. Rosa, L. Shirley, M. E. Gavarrete, W. V. Alangui (Eds.) *Ethnomathematics and its diverse Approaches for Mathematics Education* (pp. 3-19), ICME13 Monographs. London, England: Springer Open.

Rosa, M., & Orey, D. C. (2005). Las raízes históricas del programa etnomatemáticas [Historical roots of the ethnomathematics program]. *RELIME, 8*(3), 363–377.

Rosa, M., & Orey, D. C. (2010). Ethnomodelling: A pedagogical action for uncovering ethnomathematical practices. *Journal of Mathematical Modelling and Application, 1*(3), 58–67.

Rosa, M. & Orey, D. C. (2011). Ethnomathematics: The Cultural Aspects of Mathematics. *Revista Latinoamericana de Etnomatemática, 4*(2), 32-54.

Rosa, M., & Orey, D. C. (2012). An ethnomathematical study of the symmetrical freedom quilts. *Symmetry: Culture and Science, 23*(2), 191–220.

Rosa, M., & Orey, D. C. (2015). A trivium curriculum for mathematics based on literacy, matheracy, and technoracy: An ethnomathematics perspective. *ZDM*, *47*(4), 587–598.

Rosa, M., & Orey, D. C. (2016). Innovative approaches in ethnomathematics. In M. Rosa, U. D'Ambrosio, D. C. Orey, L. Shirley, W. V. Alangui, P. Palhares, & M. E. Gavarrete (Eds.), *Current and future perspectives of ethnomathematics as a program* (pp. 18–23). ICME13 Topical Surveys. London, England: Springer Open.

Seah,W. T., & Bishop, A. J. (2003).Values, mathematics and society: Making the connections. *Prime Number*, *18*(3), 4–9.

Septianawati, T., & Puspita, E. (2017). Ethnomathematics study: uncovering units of length, area, and volume in Kampung Naga Society. In *Journal of Physics: Conference Series 812*(1), 012021. IOP Publishing.

Sharma T., & Orey D.C. (2017) Meaningful Mathematics Through the Use of Cultural Artifacts. In. Rosa M., Shirley L., Gavarrete M., Alangui W. (Eds.) *Ethnomathematics and its Diverse Approaches for Mathematics Education.* (pp. 153-179). ICME-13 Monographs. Springer, Cham.

Sharp, J. M. (1999). A Teacher-Researcher Perspective on Designing Multicultural Mathematics Experiences for Preservice Teachers. *Equity & Excellence, 32*(1), 31-42.

Shockey, T. L. (2002). Etnomatematica de uma classe pro fi ssional: Cirurgiões cardiovasculares [Ethnomathematics a Professional Class: Cardiovascular

Surgeons]. *Bolema, 15* (17), 1–19.

Shuaibu, G. (2014). Mathematics in Hausa culture: some examples from Kano State-Nigeria. *IOSR J. Math. (IOSRJM), 10*(2), 167-171.

Sunzuma, G., & Maharaj, A. (2020). In-service mathematics teachers' knowledge and awareness of ethnomathematics approaches. International Journal of Mathematical Education in Science and Technology, 1-16.

Supriadi, S. (2019). Didactic Design of Sundanese Ethnomathematics Learning for Primary School Students. *International Journal of Learning, Teaching and Educational Research, 18*(11).154-175.

Supriadi, S. (2020) Pre-service elementary teachers: analysis of the disposition of mathematical modeling in ethno mathematics learning. *Elementary Education Online*, *19*(3), 1407-1421.

Supriadi, Suryadi, D., Sumarmo, U., Rakhmat, C. (2014). Developing Mathematical Modeling Ability Students Elementary School Teacher Education through Ethnomathematics-Based Contextual Learning. *International Journal of Education and Research, 2*(8), 439-452.

Wedege, T. (2010). Ethnomathematics and mathematical literacy: People knowing mathematics in society. In C. Bergsten, E. Jablonka, & T. Wedege (Eds.), *Mathematics and mathematics education: Cultural and social dimensions: Proceedings of MADIF7, The Seventh Mathematics Education Research Seminar, Stockholm, January 26 – 27, 2010* (pp. 31–46). Linköping, Sweden: Svensk Förening för Matematikdidaktisk Forskning (SMDF).

Widada, W., Sunardi, H., Herawaty, D., Boby, E., & Syefriani, D. (2018). Abstract Level Characteristics in SOLO Taxonomy during Ethnomathematics Learning. *International Journal of Science and Research, 7*(8), 352–355.

Widada, W., Herawaty, D., Anggoro, A. F. D., Yudha, A., & Hayati, M. K. (2019, April). Ethnomathematics and outdoor learning to improve problem solving ability. In *International Conference on Educational Sciences and Teacher Profession*, 295, 13-16. ICETeP 2018. Atlantis Press.

Verner, I., Massarwe, K., & Bshouty, D. (2013). Constructs of engagement emerging in an ethnomathematically-based teacher education course. *The Journal of Mathematical Behavior, 32*(3), 494–507.

Vithal, R., & Skovsmose, O. (1997). The end of innocence: A critique of

"ethnomathematics". *Educational Studies in Mathematics, 34*, 131–158.

Yolcu, A. (2019). Kültürel olarak duyarlı matematik etkinlikleri. In Y. Dede, M.F. Doğan & F. Aslan-Tutak (Eds.), *Matematik Eğitiminde Etkinlikler ve Uygulamaları* (pp. 467-487). Ankara: Pegema Yayıncılık.

Yusuf, M. W., Saidi, I. ve Halliru, A. (2010). Ethnomathematics: a mathematical game in the Hausa culture. *International Journal of Mathematical Science Education*, *3*(1), 36-42.