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Ethnomathematics Exploration in the *Rekhi* of *Mandap* and *Havankunda*: An Ethnography from Hindu Rites and Rituals in Nepal

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Abstract

The purpose of this research is to explore the geometrical concepts embedded in Hindu rites and ritual, especially that of the *rekhi* of "*Mandap*" and "*Havankunda*". This research was a qualitative with an ethnographic study. Data were obtained through observation, field note, taken the photo of the context, and documentation. Based on the study result, it was found that there were geometry-based mathematical concepts in making and applied in 'Mandap' and "*Havankunda*". There we can see lines and angles, parallel and intersecting lines, vertically opposite angles, linear pair and alternate angles, triangles, quadrilateral, rectangle, hemisphere, circle, its center, and geometry transformation reflection, rotation, and translation. This finding can be helpful to bring mathematics closer to the reality of Hindu rituals. Besides, the conclusion of my study implies that teachers and students can explore their cultural practices and use them as the basis for teaching and learning mathematics in school.

Keywords: Ethnography, Ethnomathematics, Geometry, *Mandap* and *Havankunda*, Nepalese Hindu Rites and Ritual Culture

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Introduction

Geometry concepts are embedded in different cultural and religious activities. However, the teachers teach bookish math in schools and colleges of Nepal. At the same time, they argue that western/ academic mathematics is far from reality, rites, and ritual of different cultural groups. These arguments can be addressed with transformational effort to bring mathematics closure to the reality linking mathematics teaching and learning with the lived culture of the students as platform. If we do so, it helps reduce mathematics anxiety that the students feel and improve their score and teacher efficiency. The concept of Prahmana and D'Ambrosio (2020) and Ilyyana and Rochmad (2018) fits well. They said, situation learning might be meaningful and long-term retention if it is linked with local cultural activities (Ilyyana & Rochmad, 2018). This paves the road that ethnomathematics can be a source of knowledge to make mathematics easy to understand, make interesting and useful in daily life. In doing so, we can justify that a person/group produces both culture and mathematics in the communities through individual or social activities (Pais, 2013). It is where fits well (D'Ambrosio, 1977; Rosa & Orey, 2011; Maryati & Prahmana, 2019; Mania & Alam, 2021; Fitrianawati et al., 2020). As they said ethnomathematics is the study of the relationship between mathematics and culture or cultural aspect of mathematics or mathematics in culture.

Though working as a mathematics teacher and educator for long, we also comply with this idea; do it in my classroom and advocate it for the use of different cultural contextual activities, arts and artifacts to make school mathematics easy and meaningful. My experience resembles different kinds of literature advocating for the use of ethnomathematics (Erbilgin, 2017; Rosa & Orey, 2015; Tarman, 2016) not only as the teaching tools but as a complete learning package. Package like this will be a great resource for innovating mathematics learning, creating a contextual world by preparing them good in mathematics, making student-centered moralities (Mauluah & Marsigit, 2019). We mean that students can find mathematical contents in *rekhis* drawing activities while celebrating the Hindu cultural tradition. If we use this way, mathematics will be linked with students' real life and activities at home and community (Prahmana & D'Ambrosio, 2020; Abdullah, 2017). *Rekhi* approach of teaching math will be applicable to the Hindus, Buddhist, Islam, *Kirat*, and Christians might have similar approach that the teachers can figure out.

As suggested by National Council of Teachers of Mathematics (NCTM) (NCTM, 2000) problem-solving, reasoning and proof, communication, connections, and representations are considered essential for geometry. Also, conceptual understanding of mathematics can be built through problem solving, reasoning and argumentation. In other words, cultural activities have geometry in mathematics. Therefore, it is considered one of the essential branches to develop the students' logical capacity such as critical thinking, reasoning, examining, and imagination through high-level of mental processes (Bhagat & Chang, 2015; Brandt & Chernoff, 2015). However, as per my experience as a reflective teacher, teaching geometry connecting with specific arts and artifacts of the students' culture becomes easy and interesting (Mauluah & Marsigit, 2019). But mathematics teachers of my study area have been found focusing more on textbook-driven instruction with parrot oriented rote learning. They were not found, connecting mathematics, rules, and formulae with cultural rites and rituals.

Nepal is a rich and diversity of cultural and tradition. Therefore, among the various cultural rites and ritual religious work process, Brahmin have many rites and rituals. Math teachers can explore them while celebrating *Gharpuja*/ *GharPaicho* (for the peace and prosperity of the family before entering a newly built house), *Choodakarma*/ *Upanayan* and marriage ceremony. There one can see different shapes while drawing *rekhis* by *Puret* (priest). Initiative like this makes both students and teachers social-spirited, and responsible (Widodo, 2019).

Exploration of mathematics concepts embedded in different cultures of the people in national and abroad has documented context. There, Yogyakarta, Kraton, Yogyakarta, Mauluah and Marsigit (2019) found learning resources which can be used as media for mathematics learning about: measuring length, area, volume, tessellation, shape, pattern, common multiple, common divisor, and multiplication. Ditasona (2018) explored that some *gorga* motifs motive could generate the rules of reflection, rotation, translation, and dilatation in transformation geometry using ornaments in *batak*. Similarly, Haris and Putri (2011) explored Andaman traditional crafts could be used in mathematics learning, and Maryati and Prahmana (2019) investigated the ideas of geometric transformation in several motifs of *Anyaman* Bambu (bamboo's handicraft) that contains. On the other hand, Prahmana and D'Ambrosio, (2020) explored the mathematical concept of geometry transformation such as reflection, rotation, translation, and enlargement using the Yogyakarta culture in batik motif pattern. Finally, the Mauluah and Marsigit (2019) explored that *Kraton* Jogja has many cultures that can be used as materials in teaching mathematics, such as measuring the height of *Gunungan*, counting the area of Batik motif, counting the calendar of Sultan Agung (the king of Yogya), drawing the shape of the part of Kraton, etc.

In Banten, using Sundanese culture board media, flat rectangular shapes were used to teach mathematics through didactical design research (Supiyati et al., 2019; Hanum & Jailani, 2019; Fitrianawati et al., 2020). They found geometry teaching with elementary students connecting with Borobudur and Prambanan temples effective as they identified different shapes like squares, rectangles, triangles, and circles linking with temple shapes. On the other hand, Pradhan (2018) in the Nepalese context explored mathematical ideas embedded in the cultural artefacts of *Rangouli* mandala and claimed its use as an instructional material that mediates teaching and learning of school mathematics.

However, the review of the ethnomathematics works of literature in abroad and Nepalese context gives the clue that students and teachers familiar to those cultures, context and patterns in the making can relate mathematics concepts for learning academic/western/ formal mathematics. Therefore, this research aims to explore study, we are interested in exploring the concepts in local Hindu rites and rituals of "*Mandap*" and "*Havankunda*." Therefore, this research aims to explore ethnomathematics or school level geometrical ideas, ways and techniques that have been used and developed by *Puret* in Hindu Brahmin cultural rites and rituals cultural activities and building "*Mandap*" and "*Havankunda*." The hope is that the results of this study can contribute especially the mathematical Geometry concept of ethnomathematics in Brahmin Cultural that can be used as a context in close learning of mathematics Geometry contents and can be desired by students. Thus, it can minimize the less interested, less motivated and difficulty of students in learning mathematics and use it in dealing with problems in the reality of student life. In addition, the study is expected to be an inside reference for teachers and researchers in developing ethnomathematics-based learning designs. Therefore, teaching and learning mathematics from *Bramin* cultural activities of *rekhi* drawings and constructing and decorating "*Mandap*" and "*Havankunda*" by colorful *rekhis* of rice powder gave me intuition to bridge the academic mathematics linking with ethnomathematics.

Methods

This study used an ethnography approach because it describes a communities' cultural practices (Spradley & Mc Curdy, 1989). This is descriptive qualitative, exploratory, inductive, and empirical research. It aims to explain and obtain information from the cultural practices of drawing *rekhi*. In this sense, it is culture-based field research (Chen et al., 2018; Walter & Ophir, 2019; Prahmana et al., 2017). This research was conducted in November 2020. This study took place in rites and ritual activities of Gharpaicho Puja at home of Brahmin community located at Pokhara Metropolitan City Bagar Ward no.1.

We carried out the field study purposively. For this, we spent two days there. However, as a member of Brahmin community, we have my life experience. As an ethnographer, we collected the data by following a social constructivist epistemology process. We involved in the field, observed the direct approach, explored, and clarified broadly how pure of Brahmin community constructed *rekhi* in "*Mandap*" and "*Havankunda"* in a natural setting. We also tried to develop deep understanding about how we can relate these shaped, their used rules while teaching school geometry (Aliya et al., 22nd December 2015, p. 11). With the Puret's consent, we took the field note, photo, and video as the documentation. Then we analyzed the field data using the triangulation technique and finally described to explore each finding in this study. The data collection results were analyzed using the source triangulation technique. We comprehensively explored the relationship between geometrical knowledge and the Brahmin's cultural *rekhi* doing practice during this time. Lastly, the findings are described as the results of this study. The data analysis used the ethnographic approach proposed by Spradley (2006), namely domain analysis, taxonomic analysis, component analysis, and discovery of cultural themes.

Results and Discussions

While constructing "*Mandap*" and "*Havankunda*", *Puret* used their techniques labeled as concept of geometries and its application in shapes and rules such as parallel and intersecting lines, vertically opposite angles, triangles, rectangle, rhombus, circle, its center, and hemisphere. It is also the concepts of geometrical transformation such as mirroring (reflection), shift (translation), rotation, and resizing (dilation). A more detailed explanation of each *rekhi* drawing patterns and used materials is given in the succeeding paragraphs. If observed, students and teachers can see it depending on their experiences, creativity, cultural traditions, and the lived context.

From the *Rekhi* of "*Huvankunda*" to Geometry: Lines, Angles, Triangles, and Rectangles

Besides, in the process of making "*Huvankunda*" made by yellow and red powders mixing with white gridding rice *rekhis*, it used the concept of geometrical shapes lines, angles, triangles, quadrilateral and rectangles. A line segment is the part of line with two endpoints. The angle is the corner which is formed when the two lines meet at a common vertex. However, as the example we took below the center part of the "*Huvankunda*".

There, we leveled with giving the name of the vertices. HU and DE are intersecting lines at vertex F. A pair of vertically opposite angles <HFD and<UFE are formed by *rekhi*. We can measure the angles by keeping the protractor know the details about their properties. Also, linear pair angles < *rekhi* lines form HFE and <UFE. Similarly, ∆HDF and quadrilateral FUWE are seen. When we observed the center of Huban, *Puret* made rectangle shapes using pieces of sand and redesigned by drawing colorful *rekhis*. We labelled it by giving the name of the vertices DBCP, which is a rectangular shape. Inside it, we also can see another small rectangle SRQP. Hence, these are similar rectangles. If we reconstruct the line PR and QS, they are diagonals of the rectangles intersected at the center of *Huvankunda* 'O', presented in Figure 1.

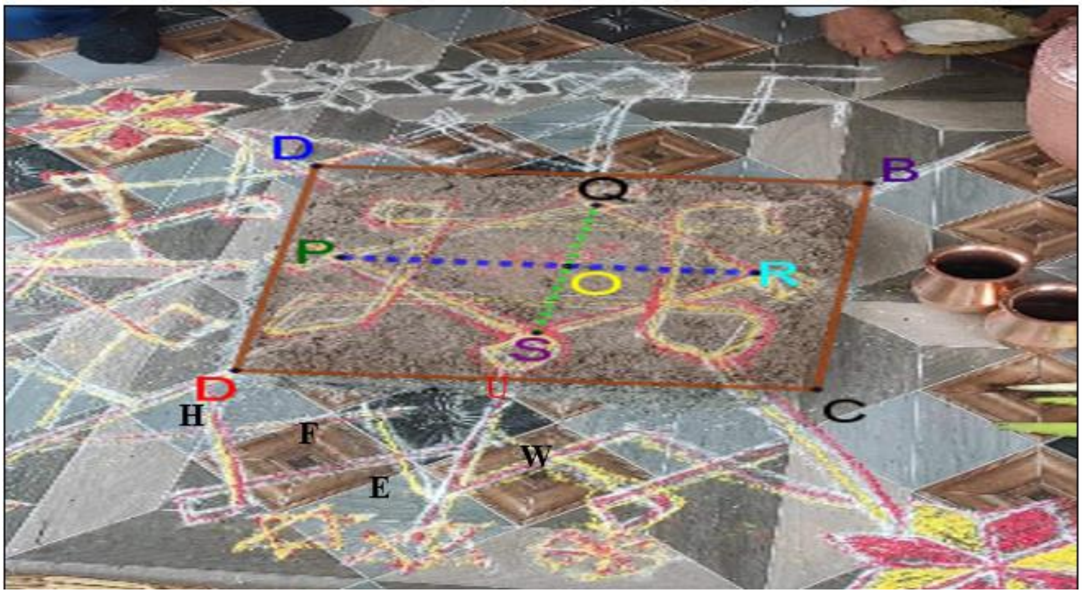

Figure 1. Geometry conceptualization lines, angles, triangles, rectangles etc. from *rekhis* with stands in *Huvankunda*

Mandap and *Huvankunda*: Mensuration with Geometry

In decorating "*Mandap*" and "*Huvankunda*", *Puret* used different home materials to shape it as hemisphere called *Aari* in the Nepali language. The *Aari* is made by cupper. One can see the same shapes of the leaf of *katush* in a circular shape. In this religious ritual, we can see center of circle, congruent circles, intersecting and parallel wooden pieces. *Puret* fills the *Aari* with rice.

The *Puret* and *Karatas* sit on the new *Guendri* and *Tharkati* (the smallest of Guendri). *Guendri* (mat) made from paddy plants. In *Guendri* and *Tharkati*, we can see patterns of congruent pieces of rectangles. These all activities are considered as for the peace, promising wealth and prosperity of the family members entering a newly built house.

In making this *Huvankunda*, *Puret* uses the concept of geometrical shapes related to mensuration as given in Figure 2.

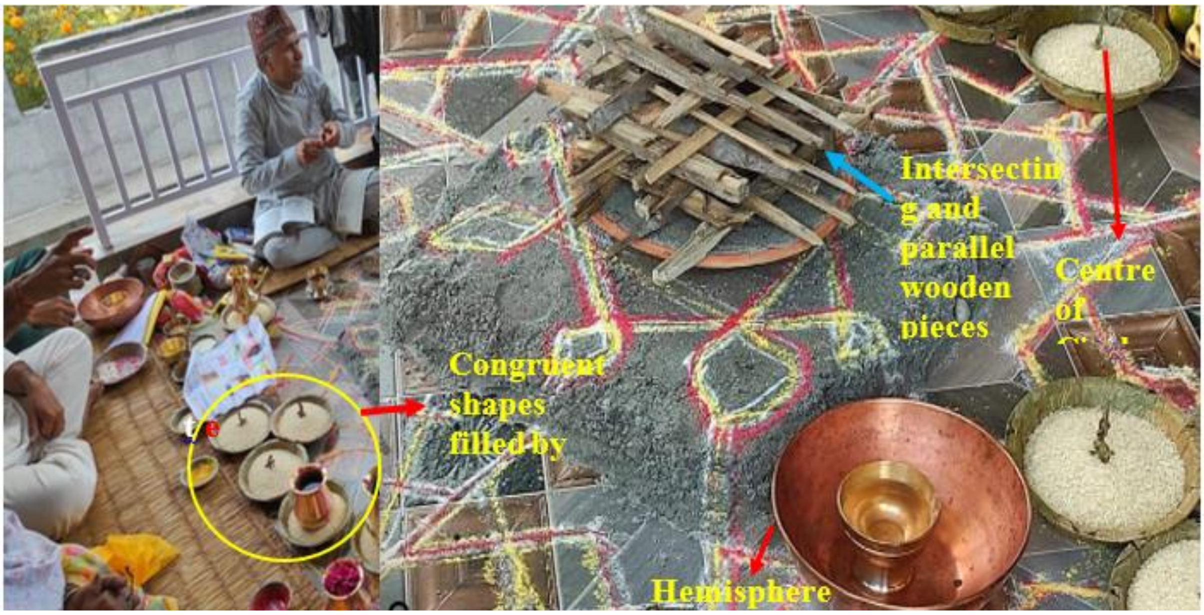

Figure 1. Mathematization concept of hemisphere, congruent circles, rectangles, and intersecting lines from *Gharpaincho* puja

Transformation Geometry

Transformation of geometry means change. So, it is a special kind of one-to-one mapping from plane to plane by changing the position or size of a geometrical figure. Therefore, the object's isometric transformation (reflection, rotation, and translation) size does not change. Still, the position of the object changes, and the non-isometric transformation (dilatation: enlargement or reduction) size of the figure only changes. Therefore, the transformation of geometry using coordinates and non-use is to change. Hence, each point of the object coordinates; they transform into image, which again coordinates the geometrical figure on a plane with a specific rule. Some colorful *rekhis* shapes and patterns in *Gharpaincho* Puja can be seen in the transformation principles of the school mathematics curriculum of the basic and secondary level (grades 7, 8, 9, and 10) of Nepal.

Reflection and Translation

Reflection is the transformation that moves each point on a plane by using the mirror image under the properties of a straight line joining each point and corresponding image point equidistance to the axis of reflection. Also, translation is a transformation that moves each point on a plane by a certain distance and direction. A directed line segment can represent the distance and direction of a translation. The figure

3, reflected a triangle ABC formed by *rakhi* lines on the vertical “Y” axis (line YOY’). Its image seems triangle A’B’C’ because points and their images are equidistant from the axis of reflection on the Y-axis.

Similarly, shape ‘1’ image seems shape ‘2’ under reflection on the vertical “Y” axis (line YOY’). However, the image of segment SC seems SB reflected on the horizontal “X” axis or (line XOX’). The points S on the ‘X’- axis are invariant points because their images are themselves after reflection on X-axis called identity transformation. These objects are reflected in a point or a line. The line that is used as an object mirroring line is called the mirroring axis or the symmetry axis. The reflection properties in the above figure are the distance from the origin to the mirror equal to the distance of the mirror to the shadow points and the line connecting the origin with the point of the shadow perpendicular to the mirror. Similarly, constructed shapes of *rekhi* and patterns in “*Mandap*” in *Gharpaincho* Puja also formed the translation of one object. In Figure 3, the shape B is the translation of to shape D and shape A is the translation of shape C and vice versa.

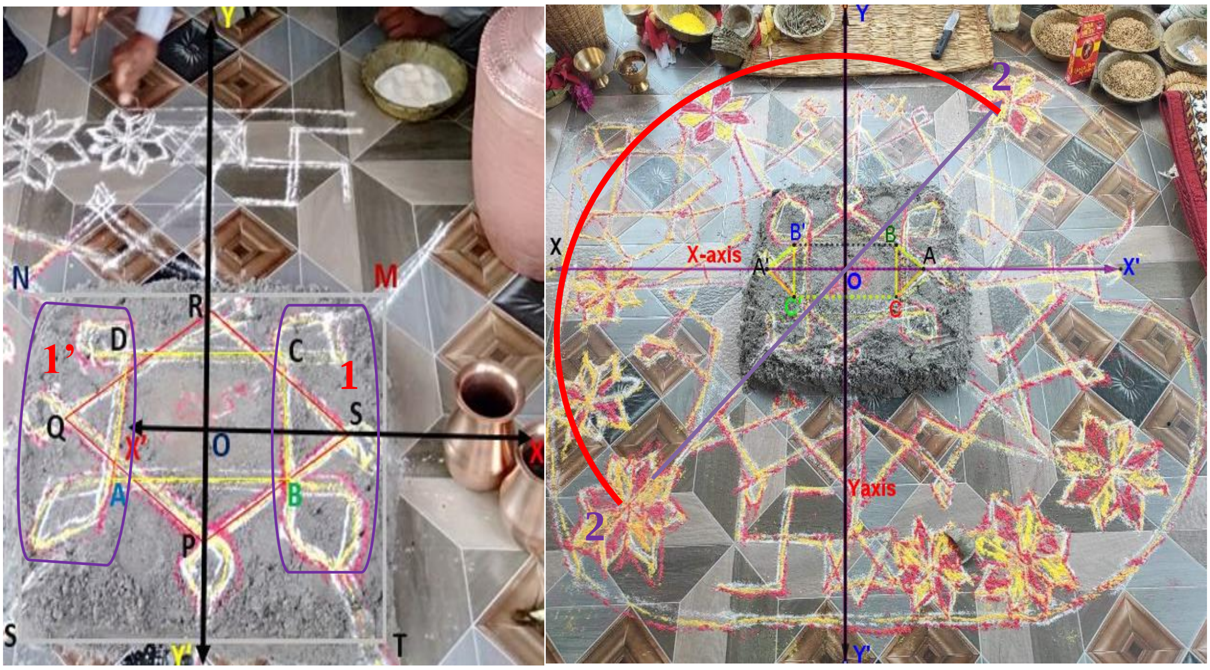

Figure 3. Geometry Transformation Reflection and Translation: From *Rekhis* in “*Mandap*” and “*Huvankunda*”

Rotation

Rotation is a transformation in which each point of the object or the solid item is rotated through a certain angle (α) about the fixed point. It is also called the center of rotation. Rotation is determined by the center of rotation, the magnitude of the rotation angle, and the direction of the rotation angle. Angular rotation is the angle between the line connecting the origin and center of rotation with the line connecting the image point and the center of rotation. Therefore, if the rotation is made on anti-clockwise direction, rotation is positive and anti-clockwise direction; and rotation is negative. In addition, the materials and *rekhi* patterns of "*Mandap*" and "*Huvankunda*" can be used as the concept of geometrical transformation in the form of rotation.

Figure 4. Rotation about center 'O' through ±180° or -90° materials used in Puja

In Puja, there seem materials such as *karuwa* (A) decorating with colors *rekhis* lines placed over the rice grains. It is kept upon the *tapari* (leaf plate made of *Katus*) of rice. *Katus* tree can be applied for rotation through 180° clockwise (-90°) or anticlockwise + 270° about the center of rotation is the center 'O' of *Havankunda*.

Conclusion

This study finding showed that school math is there in cultural rites and rituals. This mathematics can be used for teaching and learning math. It can teach the process in a simpler way and can help learn abstract concepts of school geometry easily. The *Mandap* and *Havankunda*'s *rekhis* in *Gharpaincho* Puja can give the concept of geometry about lines (intersecting, curve, parallel and non-parallel lines), angles (vertically opposite, linear pair, alternate, triangles), quadrilateral and rectangles and its diagonals, hemisphere, circle, and geometry transformation rules of reflection, rotation, and translation. Such Hindu cultural contextual activities can be used as a mathematics teaching and learning platform to improve the students' understanding of geometry learning by researching. Of course, such activities can make students or teachers, or the public better understand how their cultural rites and ritual experience can be related to geometry contents to learn in an easy and interesting way.

Finally, we conclude that the finding of the research supports to bridges between academic school geometry and ethnomathematics of everyday life. For further research, one can observe what kind of local mathematics and rules are used by the *Puret* while constructing and decorating "*Mandap*" and "*Huvankunda*".

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Declarations

Author Contribution	:	KDP: Conceptualization, Writing - Original Draft, Editing and Visualization; BNK: Writing - Review & Editing, Formal analysis, and Methodology Validation and Supervision
Conflict of Interest	:	The authors declare no conflict of interest.

References

Abdullah, A. S. (2017). Ethnomathematics in perspective of Sundanese culture. *Journal on Mathematics Education*, *8*(1), 1-16.

Aliyu, A. A., Singhry, I. M., Adamu, H. A. R. U. N. A., & Abu Bakar, M. A. M. (2015). Ontology, epistemology, and axiology in quantitative and qualitative research: Elucidation of the research philosophical misconception. In *Proceedings of the Academic Conference: Mediterranean Publications & Research International on New Direction and Uncommon* (Vol. 2, No. 1).

Bhagat, K. K., & Chang, C. Y. (2015). Incorporating GeoGebra into geometry learning-A lesson from India. *Eurasia Journal of Mathematics, Science and Technology Education*, *11*(1), 77-86.

Brandt, A., & Chernoff, E. (2015). The importance of ethnomathematics in the math class. *Ohio Journal of School Mathematics, 71*(1), 31–37.

Chen, N., Drouhard, M., Kocielnik, R., Suh, J., & Aragon, C. R. (2018). Using machine learning to support qualitative coding in social science: Shifting the focus to ambiguity. *ACM Transactions on Interactive Intelligent Systems, 8*(2), 1–20.

D'Ambrosio, U. (1990). The role of mathematics education in building a democratic and just society. *For the Learning of Mathematics*, *10*(3), 20-23.

Ditasona, C. (2018). Ethnomathematics exploration of the Toba community: Elements of geometry transformation contained in Gorga (Ornament on Bataks House). *IOP Conference Series: Materials Science and Engineering*, *335*(1), 012042.

Erbilgin, E. (2017). A Comparison of The Mathematical Processes Embedded in The Content Standards of Turkey and Singapore. *Research in Social Sciences and Technology (RESSAT), 2*(1), 53-74.

Fitrianawati, M., Sintawati, M., & Retnowati, M. E. (2020). Developing ethnomatematics in geometry learning for elementary schools' students: A preliminary design. *International Journal of Science and Technology Research, 9*(01), 2754-2758.

Haris, D., & Putri, R.I.I. (2011). The role of context in third graders 'learning of area measurement. *Journal on Mathematics Education, 2*(1), 55–66

Hourigan, M., & Leavy, A. (2017). Using architecture as a context to enhance students' understanding of symmetry. *Australian Primary Mathematics Classroom*, *22*(2), 8-13.

Ilyyana, K., & Rochmad. (2018)). Analysis of problem-solving ability in quadrilateral topic on model eliciting activities learning containing ethnomathematics. *Unnes Journal of Mathematics Education Research (UJMER), 7*(2), 130-137.

Mania, S., & Alam, S. (2021). Teachers' perception toward the use of ethnomathematics approach in teaching math. *International Journal of Education in Mathematics, Science and Technology*, *9*(2), 282-298.

Maryati & Prahmana, R. C. I. (2019). Ethnomathematics: Exploration of the Muntuk community. *International Journal of Scientific and Technology Research*, *8*(6), 47-49.

Mauluah, L., & Marsigit. (2019). Ethnomathematics for elementary student: Exploration the learning resources at Kraton Yogyakarta. *International Journal of Scientific and Technology Research, 8*(7), 776-780.

NCTM. (2000). *Principles and Standards for School Mathematics*. Reston, VA: The National Council of Theacher of Mathematics, Inc

Pais, A. (2013). Ethnomathematics and the limits of culture. *For the Learning of Mathematics, 33*(3), 2-6.

Pradhan, J. B. (2018). Mathematical ideas in cultural artefacts: A metaphor for teaching of school mathematics. *International Journal of Scientific and Research Publications, 8*(9), 335-341.

Prahmana, R. C. I., & D'Ambrosio, U. (2020). Learning geometry and values from patterns: Ethnomathematics on the Batik patterns of Yogyakarta, Indonesia. *Journal on Mathematics Education, 11*(3), 439-456.

Prahmana, R. C. I., Kusumah, Y. S., & Darhim. (2017). Didactic trajectory of research in mathematics education using research-based learning Didactic trajectory of research in mathematics education using research-based learning. *Journal of Physics: Conference Series, 893*(1), 012001.

Rosa, M., & Orey, D. (2011). Ethnomathematics: the cultural aspects of mathematics. *Revista Latinoamericana de Etnomatemática: Perspectivas Socioculturales de La Educación Matemática*, *4*(2), 32-54.

Rosa, M., & Orey, D. C. (2011). Ethnomathematics: the cultural aspects of mathematics. *RevistaLatinoamericana de Etnomatemática, 4*(2). 32-54.

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

Spradley, J. P., & McCurdy, D. W. (1989). *Anthropology: The cultural perspective*. Reissued Long Grove, IL: Waveland Press.

Supiyati, Hanum, F., & & Jailani. (2019). Ethnomathematics in Sasaknese architecture. *Journal on Mathematics Education, 10*(1), 47–58.

Tarman, B. (2016). Innovation and education. *Research in Social Sciences and Technology, 1*(1), 77-97.

Walter, D., & Ophir, Y. (2019). News frame analysis: An inductive mixed-method computational approach. *Communication Methods and Measures*, *13*(4), 248-266.

Widodo, H. (2019). The role of school culture in holistic education development in Muhammadiyah Elementary School Sleman Yogyakarta. *Dinamika Ilmu: Jurnal Pendidikan*, *19*(2), 265-285.