Exploration of Ethnomathematics at *Rumah Gadang* Minangkabau to Design Mathematics Learning Based on RME in Junior High Schools

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**ABSTRACT**

In the Rumah Gadang Minangkabau architecture, various aspects of Ethnomathematics can be raised as real and exciting mathematics learning topics. These aspects have not been well explored and documented. This study aims (1) to explore the mathematical ideas contained in the construction and design process of the Rumah Gadang Minangkabau, (2) to design mathematics-learning tools based on realistic mathematics education (RME) sourced from Ethnomathematics at the Rumah Gadang Minangkabau. The study uses a combination of ethnographic and design research. Ethnographic research has explored Ethnomathematics in building and designing a Rumah Gadang in Minangkabau (covering Darek, coastal, and Rantau areas). Data collection techniques at this stage: in-depth interviews with key informants (Senior Builder, Carvers, Ninik Mamak, Traditional Leaders, and others.), observations, and manuscript analysis. The identified ethnomathematics aspects are integrated into the RME-based learning tool using design research, consisting of a preliminary phase, a prototyping phase, and an assessment phase. The RME-based learning design prototype has been validated by several experts (RME and Ethnomathematics experts, learning technology, and languages), and practitioners through focus group discussion (FGD) activities. Furthermore, the learning design was evaluated formatively (one to one and small group) to investigate its practicality. The collected data were analyzed using descriptive and inferential statistics.

**Keywords:** Ethnomathematics, Rumah Gadang Minangkabau, RME.

1. **INTRODUCTION**

Minangkabau is an affluent area in culture and customs. One of the unique elements of Minangkabau culture is the Rumah Gadang. Rumah Gadang building construction is unique and exciting. The shape is big upwards, almost like a boat. It is because the poles are erected at a 91° - 94° slope. The Rumah Gadang is determined by the amount of space (long section) and lanjar (width section). The length of the Rumah Gadang generally varies between 3, 5, 7 to 9 spaces (odd numbers). Besides, the connecting devices between one and another are pegs and pins, made of wood [1], [2].

From the preliminary study, many elements of Ethnomathematics were found in the design of the Rumah Gadang. The search results [3] and [4] show that the elements of Ethnomathematics are also found in the Rumah Gadang design, structure, and construction process. Ethnomathematics elements in the Rumah Gadang are very likely to become an exciting context in learning mathematics. Those, in the design and architectural philosophy, there are various mathematical concepts. [5] Moreover, [6] reveal the many symmetrical concepts in the carvings in the Rumah Gadang.

Considering that each area in Minangkabau, which includes 'darek,' coastal and 'rantau' areas, has many Rumah Gadang with its peculiarities, it is deemed necessary to explore the Ethnomathematics contained in the Rumah Gadang. This exploration is carried out with three main objectives. First, preserve the elements and cultural values in the design, structure, and process of building a Rumah Gadang. The existence of the Rumah Gadang is threatened with extinction and is decreasing in number [7]. Due to age and maintenance factors that damage the Rumah Gadang, documenting the Ethnomathematics elements in the Rumah Gadang is very important.
The second, to provide scientific and empirical evidence to the world of education about the relationship between mathematics and culture, especially those found in the Minangkabau Gadang house. According to [8], mathematics is a form of culture. As a form of culture, mathematics has been integrated into all aspects of people's lives everywhere. Their cultural background influences a person's mathematics because they are based on what they see and feel [8]. Thus, the assumption that mathematics has nothing to do with culture is the wrong assumption.

The above description implies that teachers must show perceptions and attitudes that mathematics is closely related to culture and everyday life to know how to use mathematics in their lives [9]. Besides, [10] stated that mathematics is a human activity and must be related to life's reality.

Third, referring to the close relationship between mathematics and culture, the Ethnomathematics contained in the design, structure, and process of building a Rumah Gadang are believed to be an exciting and realistic context for students to be used as starting points in mathematics learning. Realistic mathematics education (RME) is a learning approach that makes context and contextual problems the main elements for starting mathematics learning.

RME context does not only show the relationship between mathematics and the real world (real world) but refers to situations that can be imagined (imaginable), suitable and real in the minds of students [11], [12]. The use of context in questions affects students' responses. Students themselves can provide the correct answer based on their daily lives [13].

The use of context in mathematics learning is also useful for students in establishing direct relationships between mathematical contexts and ideas to support students' development in mathematical thinking [14]. The context will lead students to understand mathematics from something real for students to become something formal that can be written with symbols through the mathematical stage [15].

In this study, the context provided in RME uses the ethnomathematics concept. The term ethnic refers to all the components that build a culture's identity, such as language, code, values, jargon, beliefs, food and clothing, habits, and physical characteristics [16]. Ethnomathematics is seen as a scientific discipline that combines the interrelationships of culture and mathematics.

Learning with the Ethnomathematics approach has been proven to increase motivation, the achievement of students’ mathematical abilities, retention, and overcoming boredom and difficulties of students in learning mathematics [17], [18], [19]. Likewise, the use of cultural contexts in mathematics learning with the RME approach has increased the achievement of learning mathematics, critical thinking skills, and right character/attitude [20], [21], [22], [23], [24].

2. METHOD

The study uses a combination of ethnographic and design research. In essence, ethnographic research emphasizes documenting and describing individuals' daily experiences by observing and interviewing them [25], [26]. Through ethnographic research, Ethnomathematics will be explored in the process of building and designing Rumah Gadang in Minangkabau (covering darek, coastal, and rantau areas). Data collection techniques use participatory observation, in-depth interviews with key informants (Senior Builder, carvers, Ninik Mamak, Traditional holders, and others.), and documentation studies (manuscript analysis).

Data analysis was carried out before entering the field, during the field, and after completion. Data analysis was carried out in three steps: 1) data reduction/codification, 2) data presentation, and 3) concluding.

From the ethnographic research conducted, aspects of Ethnomathematics in the Rumah Gadang Minangkabau will be identified. These aspects will be grouped into five mathematical ideas: counting, measuring, locating, designing, playing, and explaining.

After the Rumah Gadang Minangkabau Ethnomathematics aspects are identified, an RME-based learning tool will be designed using a research design consisting of a preliminary phase, a prototyping phase, and an assessment phase [27]. Research activities at the preliminary stage consist of the curriculum analysis and concept analysis to integrate the five mathematical ideas. Based on the analysis results, the prototyping phase designed an RME-based mathematics learning design for SMP. Several experts (RME and Ethnomathematics experts, learning technology, and languages) and practitioners through focus group discussion (FGD) activities will validate the RME-based learning design prototype. Furthermore, the learning design will be evaluated formatively (one to one and small group) to investigate its practicality.

For formative evaluation of all products produced in this study, the steps proposed by Tessmer are used, as shown in Figure 1.
3. RESULT AND DISCUSSION

Based on the exploration results, ethnomathematics aspects were identified in the Rumah Gadang, namely: 1) The idea of counting (associating objects into numbers) is on the stairs, and the number of space slopes the Rumah Gadang, which must always be odd, 2) The idea of measuring (comparing, predicting and calculating the quality) is found in the length of the room of a Gadang which is not always the same length and also the length of which is not always the same, 3) The idea of locating, (topography and cartography / spatial) is found in the selection the location of the Rumah Gadang building, 4) Designing ideas, (conceptual artifacts/ideas about shape) are found in the carvings in the Rumah Gadang and their meanings, 5) Playing ideas (procedures and rules) are found on the wood that forms the roof Gadang and Rumah Gadang stairs.

The idea of playing on the number of steps in a Rumah Gadang is where the number of children must be odd, namely 3, 5, 7, or 9 steps. It is closely related to the house’s function to raise chickens, goats, cows, or weaving places for women. 6) Explaining ideas (relating to the cognitive aspects of conceptualization and explanation of the concept).

After exploring the Rumah Gadang and obtaining the mathematical ideas contained therein, these ideas are integrated into mathematics learning tools based on realistic mathematics education (RME) on the topic of flat wakes. seen in figure 3.

After preliminary analysis and self-evaluation, the learning device was validated by five experts consisting of three mathematicians, one linguist, and one educational technology expert. The experts’ evaluations obtained an average of 3.66, which is in the very valid category.

After the learning design is valid, it is followed by a one to one evaluation trial on three high, medium, and low ability students. The following is an example of the answers of students in the one to one stage can be seen in Figure 4.
After the one to one stage, a small group evaluation was carried out on six students: two high, two moderate, two low ability students. The following are examples of students’ answers, which can be seen in Figure 5.

After conducting a small group evaluation, interviews were conducted with two students who were representatives of each group. From the interviews conducted, it was concluded that students liked LKPD based on Ethnomatics of Rumah Gadang, with LKPD based on ethnomatics of Rumah Gadang, can help them find and understand every material studied.

Apart from interviews, students were also given a questionnaire to see the practicality of the learning tools used. Based on students’ practicality questionnaire results, the table shows three practical aspects, namely didactic aspects, ease of use, and time. The presentation/didactic aspect has a practicality value of 88.19%, the ease of use aspect has a value of 90.97% in the efficient category, the time aspect has a value of 91.67%, it is also in the efficient category. In contrast, the readability aspect has a practicality value of 83, 33, in the practical category, so that the average practicality value of the whole device is 88.54% with the efficient category.

4. CONCLUSION

Based on the study results, it can be concluded that the RME learning design, which is compiled based on the exploration results of the Minangkabau Rumah Gadang, has been in the valid and practical category to be used in the next stage, namely the field test.

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REFERENCES

[1] Soeroto, M., 2005. Library of Culture and Architecture: Minangkabau. Jakarta: Myrtle Publishing. (Originally in Indonesian)

[2] Syamsidar. 1991. Regional Traditional Architecture of West Sumatra. Jakarta: Depdikbud, Directorate General of Culture, Directorate of History and Traditional Values Inventory and Development of Cultural Values Project. (Originally in Indonesian)

[3] Fitriza, R., 2018. Ethnomathematics Study in Traditional Architecture of Rumah Gadang West Sumatra and Its Application in Learning Mathematics in Schools. Dissertation, Bandung Indonesian Education University. (Originally in Indonesian)

[4] Perisya. 2018. Ethnomathematics of Minangkabau Traditional House to Build Factual and Conceptual Mathematical Knowledge of Junior High School Students. Thesis, University of Pendidikan Indonesia. Bandung. (Originally in Indonesian)

[5] Fauziah and Niniwati. 2017. Ethno-mathematics Exploration on the Carvings of Rumah Gadang in South Solok Regency of West Sumatra. JRDO-Journal of Educational Research, 134-148.

[6] Khaira, K. 2017. Study of Ethnomathematics: Investigating Mathematical Ideas on the Carving of Traditional Minangkabau Traditional Houses. Thesis: Universitas Pendidikan Indonesia Bandung. (Originally in Indonesian)

[7] Noviarti, Irsa, R. and Masdar, A. 2013 Preserving Minangkabau Traditional Building in West Sumatra, Indonesia: Integration of Information
Technology. *Procedia Environmental Science*, 17, 749-756

[8] Bishop, AJ. 1997. *Mathematical Enculturation: A Cultural Perspective on Mathematics Education* (Third). The Netherlands: Kluwer Academic Publishers. [https://doi.org/10.1007/978-94-009-2657-8]

[9] Matang, R. 2005. Formalizing the Role of Indigenous Counting Systems in Teaching the Formal English Arithmetic Strategies Through Local Vernaculars: An Example From Papua New Guinea. In *Proceedings of the 28th Annual Conference of the Mathematics*.

[10] Freudenthal. 1991. *Revisiting Mathematics Education*. Dordrecht: Kluwer Academic Publisher.

[11] Wijaya. 2012. *Realistic Mathematics Education an Alternative to Mathematics Learning Approach*. Yogyakarta: GrahaIlmu. (Originally in Indonesian)

[12] Van den Heuvel-Panhuizen, M. 2003. The Didactical Use of Models in Realistics Mathematics Education: An Example from A Longitudinal Trajectory on Percentage. *Educational Studies in Mathematics*, 9-35.

[13] Johar, R., 2005. Critical Review of Leveling Proportional Reasoning. *Educational Forum*, 286-302. Research Group of Australasia (pp. 505–512). Sydney: MERGA. (Originally in Indonesian)

[14] Widjaja, W., 2013. The Use of Contextual Problems to Support Mathematical Learning. *Journal on Mathematics Education (IndoMS-JME)*, 151-159.

[15] Zulkardi. 2002. Developing An Learning Environment on Realistics Mathematics Education for Indonesian Student Teacher. Enschede: University of Twente.

[16] D’Ambrosio, U., 2001. What is Ethnomathematics, and how can it help children in schools? *Teaching Children Mathematics*, 308.

[17] Achor, EE, Imoko, BI, & Uloko, ES. 2009. Effect of Ethnomathematics Teaching Approach on Senior Secondary Students’ Achievement and Retention in Locus. *Educational Research and Reviews*, 4 (8): 385–390.

[18] Rizka, S., & Mastur, Z. 2014. Project-Based Learning Model Contains Ethnomatics to Improve Mathematical Connection Ability. *Unnes Journal of Mathematics Education Research*, 3 (2), 72–78. (Originally in Indonesian)

[19] Sirate, F. 2012. Implementation of Ethnomatematics in Mathematics Learning at Elementary School Education. *Lantera Pendidikan*, 15 (1), 41–54. (Originally in Indonesian)

[20] Athar, G. 2012. Mathematics Learning Development with a Realistic Mathematics Education Approach Based on the Culture of Riau Malay Folklore. *National Seminar on Mathematics and Mathematics Education with the theme “Contribution of Mathematics and Mathematics Education in Building Teacher and Student Character* (pp. 335-346). Yogyakarta: UNY. (Originally in Indonesian)

[21] Fitriza, R and Gunawan I. 2018. Tabuik in Building Space Learning with Realistic Mathematics Education (PMR) Approach. *Math Educa Journal*, 2 (1): 13-22. (Originally in Indonesian)

[22] Mumu, J. & Aninam, PA 2018. Context Analysis of the Origin of Papuan Culture in Realistic Mathematics Education. *Journal of Honai Math I* (1), 24-33. (Originally in Indonesian)

[23] Palinusssa, A. 2013. Students' Critical Mathematical Thinking Skills and Character: Experiments for Junior High School Students through Realistic Mathematics Education Culture-Based. *IndoMS.JME*, 4, (1), 75-94.

[24] Pirie, S. 1998. Toward a Definition for Research. Qualitative Research Methods in Mathematics Education (Teppo, AR (eds). *Journal for Research in Mathematics Education*, (9), 1–185.

[25] Fraenkel, JR, Wallen, NE, Hyun, HH 2012. *How to Design and Evaluate Research in Education*. New York: Mc-Graw-Hill