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DEVELOPMENT OF A HYPOTHETICAL LEARNING TRAJECTORY (HLT) BASED ON *RUMAH GADANG* ETHNOMATHEMATICS

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Abstract

Based on interviews, observations, and initial analysis in several schools, it is evident that the current learning process has not been connected to the students' surrounding culture. Education should integrate the roles of culture and society, as the individual development of students requires the interaction between culture and learning. This study aims to assess whether the ethno-mathematics-based Hypothetical Learning Trajectory (HLT) grounded in Rumah Gadang is effective and can help students understand the material, discover concepts, and actively engage in the learning process. This research is a Development (R&D) Research. The goal of development research is to create and validate educational products. This study follows the Plomp development model, which includes three phases: initial analysis, prototyping, and evaluation. The focus is on the results of exploring the ethnomathematics of Rumah Gadang, whose elements were investigated using ethnographic methods. These elements were then used to design several Hypothetical Learning Trajectories (HLT) for teaching mathematics in schools. This paper discusses the development of an HLT for the concept of the rhombus. The findings indicate that the HLT based on the ethnomathematics of Rumah Gadang for the topic of rhombus successfully helped students discover the concepts of the perimeter and area of a rhombus, demonstrating that the HLT is reliable and applicable in the learning process.

Keywords: Research and Development (R&D), Realistic Mathematics Education (RME), Hypothetical Learning Trajectory (HLT), Ethnomathematics, Rumah Gadang.

INTRODUCTION

Education is an intentional and carefully planned to help students achieve their full potential. The aim is for students to develop ways of thinking, moral principles, and worldviews that are consistent with traditional societal values (Achor et al., 2009; Ananda, 2018; Safitri et al., 2022)This legacy is then adapted to remain relevant to the present and future. This approach aligns with the guiding principles of curriculum development in Indonesia, which are: a) students are the creative inheritors of the nation's culture, and b) education rooted in the nation's culture to enhance the nation's life both now and in the future (Habe & Ahiruddin, 2017; Aslancı & Bayrak, 2022).

Human reason and the human mind interact during the educational process. It shows that information will enter students through this interaction. Knowledge can indeed be obtained through academic learning. However, knowledge can also be obtained outside the classroom through the community and culture of the students themselves. Wherever people live, mathematics is a kind of culture that has been incorporated into every part of everyday life (Azizah et al., 2021; Bishop, 1994). However, society still believes mathematics is final, unchangeable, singular, and unrelated to culture(Fitriza et al., 2018a; Fauzan, et al., 2020; Rewatus et al., 2020).

Education is a civilizing process (Fitriza et al., 2019; Fitriza et al., 2018b). The practice of mathematics must be grounded in the realities of life (Habe & Ahiruddin, 2017; Hamdani et al., 2023; Normina, 2017).

When used in the context of RME, the starting point in developing mathematical ideas and concepts is real world (Van den Heuvel 2020; Istiqomah & Indarini, 2021; Setiawan et al., 2022). It refers to the situation that students can understand precisely, really, and realistically rather than just describing the relationship between mathematics and the natural world with words alone (Rizka & Mastur, 2014; Ismail et al., 2022).

In helping improve the quality of learning in the classroom, the role of the teacher is significant. To improve teaching quality, teachers must be innovative and creative (Ruyadi, 2010; Kusuma et al., 2023).

Rumah Gadang is one of the cultural and architectural styles that can be used as a context for learning mathematics (Salmaini et al., 2021; Fauzan, et al., 2020) because it incorporates many mathematical ideas and concepts into architectural design and its philosophical foundations, enabling students to learn mathematics while gaining an understanding of their culture.

According to Fitriza's research, the four concepts, namely lines and angles, plane shapes, circles, and transformations, can be found through the ethnomathematics exploration of the *Rumah Gadang* (Setiawan & Fauzan, 2022; Syafriandi et al., 2020; Engen, 2021). An analysis of textbooks, lesson plans, and LKPD used in schools shows that these resources do not address the relationship between mathematics and local culture.

Based on the results of the interviews, the KKM school has set 72. There are still many students who do not reach the KKM. This fact can be seen in table 1:

Table 1: Average daily math test scores in Semester 2 of Class VII Students of SMP N 3 Padang

No	Class	Frequency	Average value
1	VII- 1	27	54,37
2	VII- 2	29	70,41
3	VII- 3	30	58,37

Based on Table 1, it is evident that the average class score is still below the KKM, indicating that the learning objectives have not been fully achieved. After analyzing the substance of the problem, it is believed that the ethnomathematics-based RME approach has the potential to connect student learning with their surrounding environment. RME provides a contextual solution to address issues in mathematics education, encouraging students to be more active in their thinking (Sunzuma & Maharaj, 2021; Prahmana et al., 2021).

Utilization of the teacher's immediate and closest environment in the classroom is known as the Ethnomatematics approach (Turmuzi et al., 2022; Widiyono 2021; Elpina et al., 2020). Using ethnomathematics in the classroom can increase students' motivation, math skills, and ability to overcome boredom and learning challenges (Yarman et al., 2021; Wikaningtyas et al., 2022; Jamaan et al., 2021).

Based on the problems above, the author has explored the ethnomathematics elements that exist in the *Rumah Gadang* so that by using these elements, several reliable ethnomathematics-based Hypothetical Learning Trajectories (HLT) are designed, which students can use to understand the material and participate actively. In the learning process. This paper will present HLT for triangles and quadrilaterals.

METHODS

This study is a component of Research and Development (R&D) research. (H. Setiawan et al., 2021). The Plomp model, which is used in this study, comprises three stages: preliminary analysis, prototype development, and evaluation. Plomp expansion design see Figure 1.

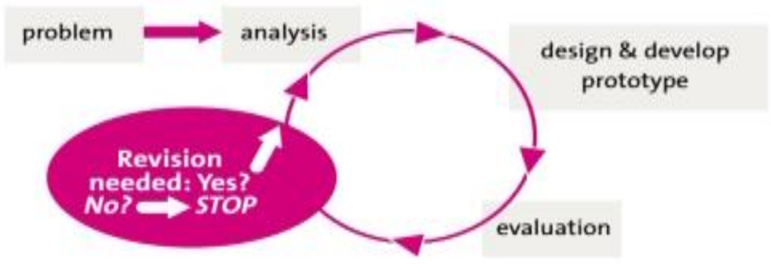
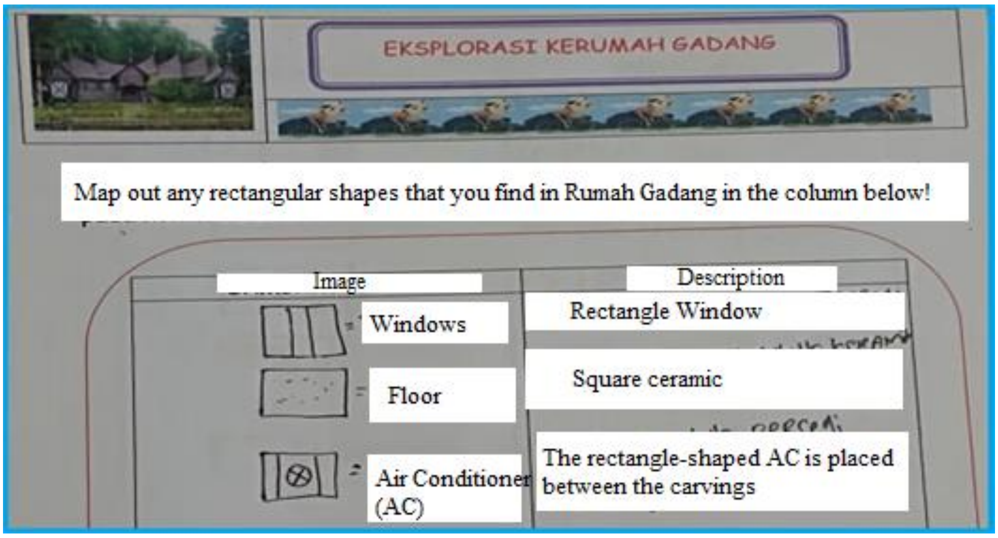


Figure 1: Plomp expansion design

This study focuses on ethnomathematics exploration of the *Rumah Gadang*, which has explored its ethnomathematics elements through ethnographic methods so that the ethnomathematics elements in the *Rumah Gadang* have been explored. Using these elements, several Hypothetical Learning Trajectories (HLT) were designed for learning mathematics at school. This paper presents the development of a HLT for Rhombus.

RESULTS AND DISCUSSION

Researchers and mathematics teachers at SMP N 3 Padang brought class VII-2 students and class VII-3 students to explore the Adityawarman Museum in Padang City. Exploration is carried out to see, identify, and find in real terms the ethnomathematics contexts that exist in the *Rumah Gadang* (Rozi Fitriza et al., 2018b) relating to the material to be studied or tested on the Ethnomatematics-based Hypothetical Learning Trajectory (HLT) of the *Rumah Gadang*, namely the topic of flat shapes (rectangles and triangles). Based on students' museum exploration results to find the ethnomathematics context of the flat shapes in the *Rumah Gadang* can be seen in Figure 2.



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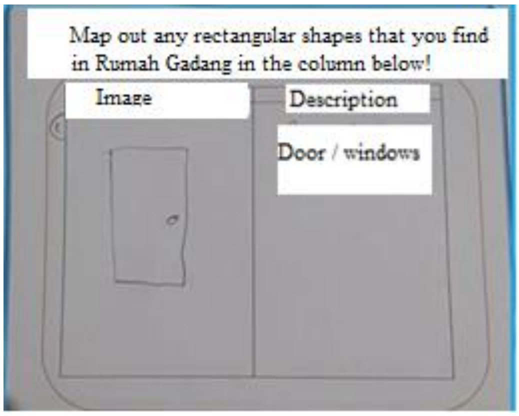

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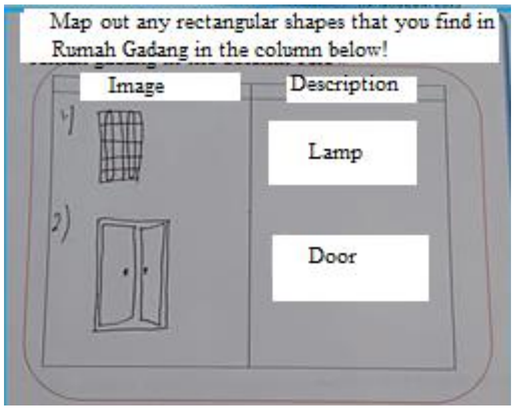

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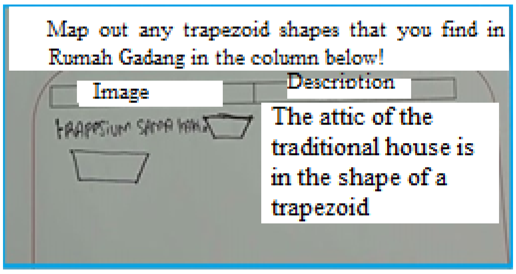

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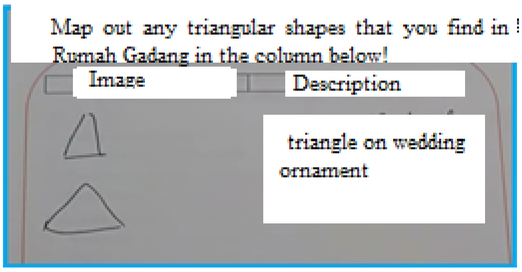

(e)

Figure 2: Exploration results of the ethnomathematics elements of the *Rumah Gadang*

The list of student identification results in the *Rumah Gadang* can be seen in Table 2.

Table 2: List of students' identification results at Rumah Gadang

Flat name	The results of the identification of flat shapes found by students in the *Rumah Gadang*
Rectangle	1) Gadang window 2) *Rumah Gadang* attic 3) Poles 4) ceramics 5) Lamp 6) Fish pond in *Rumah Gadang* 7) Picture frame 8) Granary 9) Entrance 10) air conditioning 11) *Rumah Gadang* floor
Rectangular	1) *Rumah Gadang* wall 2) *Rumah Gadang* carving 3) *Rumah Gadang* 4) *Rumah Gadang* floorboards 5) *Rumah Gadang* door 6) Security house door 7) tv 8) Artifact repository
Cut the rice cake	1) Gadang roof 2) *Rumah Gadang* carving 3) Gonjong in front of the traditional house 4) Exhibition hall carving

parallelogram	1) The pillars of the *Rumah Gadang* 2) *Rumah Gadang* wall 3) *Rumah Gadang* pillar 4) The ceiling of the *Rumah Gadang* 5) Gadang roof
trapezoid	1) *Rumah Gadang* carving 2) Gadang roof 3) *Rumah Gadang* mosque roof 4) The attic of the gadang hall 5) The glass in the *Rumah Gadang*
Kite	-
Triangle	1) Gadang roof 2) Rice barn roof 3) On the altar 4) *Rumah Gadang* carving 5) The front end of the *Rumah Gadang* 6) Peasant hat

Based on Figure and Table 2, the results of the ethnomathematics exploration carried out on the *Rumah Gadang* obtained various and many elements. It proves that the *Rumah Gadang* is relevant for use in an ethnomathematics context. Based on the results of this exploration, a Hypothetical Learning Trajectory (HLT) based on the Ethnomatematics of the *Rumah Gadang* was developed, namely the topic of flat shapes (squares and triangles).

Results of the Development of a Hypothetical Learning Trajectory (HLT) based on the Ethnomatematics Rumah Gadang rectangular topic has gone through a preliminary analysis process and product validation where the HLT has been declared valid so that it can be used in class. In the Plump development process, there are 3 trial stages: one-to-one Evaluation, small group, and field test evaluation. The problems given have been integrated with ethnomathematics. The following are the problems in the Ethnomatematics-based Hypothetical Learning Trajectory (HLT) at Rumah Gadang on the Rhombus topic.

In One-to-one Evaluation Stage, Ethnomatematics-based Hypothetical Learning Trajectory (HLT) of the *Rumah Gadang* topic of Rhombus was tested on 3 students, each of whom had different abilities. The results of student answers are presented in the following figure. Problems on the HLT topic of finding the perimeter of a rhombus can be seen in Figure 3.

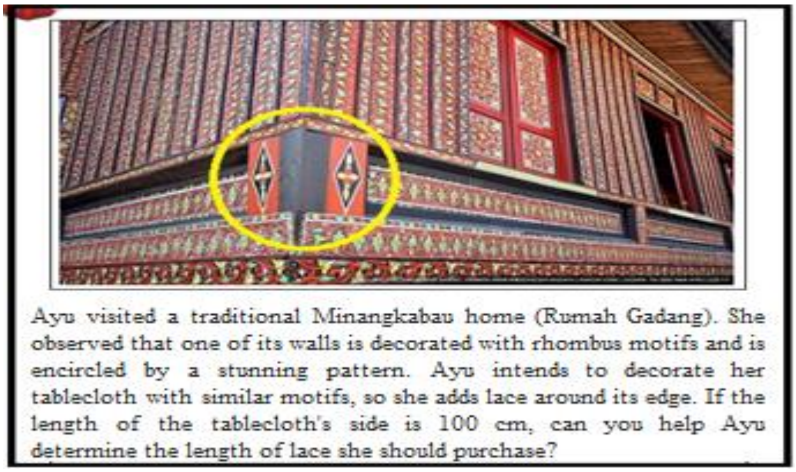

Figure 3: Problems on the HLT topic of finding the perimeter of a rhombus

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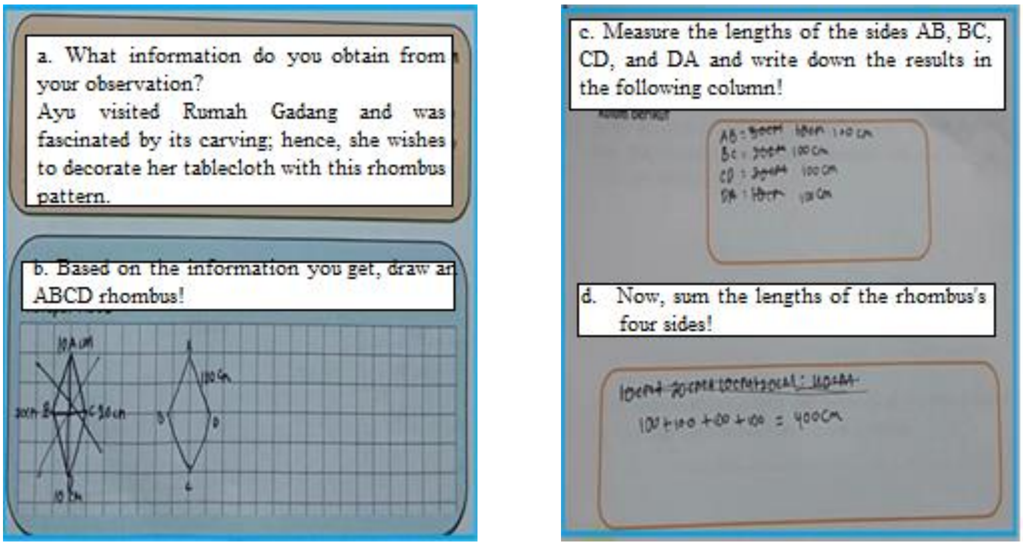
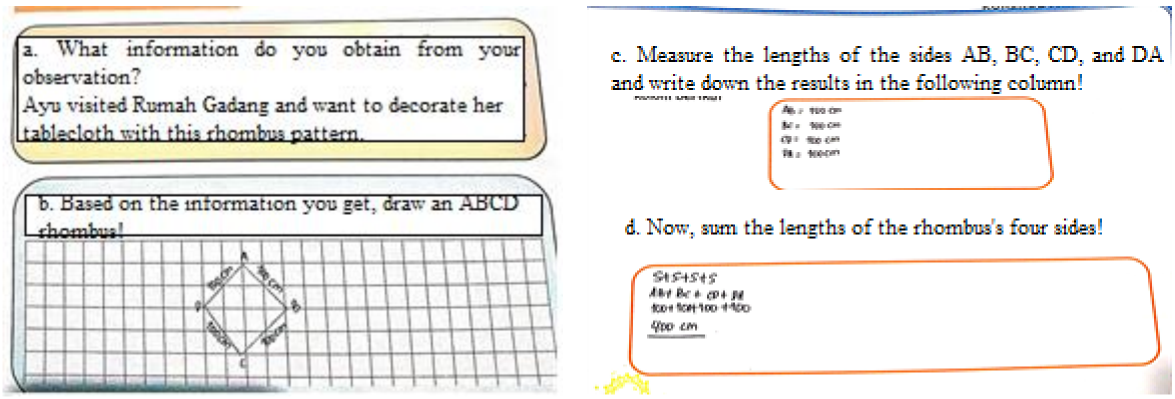
Based on Figure 3, the problems in HLT are based on the exploration results that have been carried out previously, so there is ethnomathematics integration in the problem. From the picture above, it can be seen that finding the concept of the circumference of a rhombus begins with the presentation of the ethnomathematics context of the *Rumah Gadang*. Then it is this context that students will use in the discovery process so that after following the steps in the HLT. When students solve problems on HLT, the researcher observes what the participants are doing. Educate. The following are the results of student answers can be seen in Figure 4.



(a) (b)

Figure 4: The results of the answers of students with high abilities

Based on Figure 4, in solving the problem. High-ability students start by sketching the Rhombus in the question, then determine the side lengths. In the results of high-ability students' answers, it can be seen that there was a mistake in answering where the side lengths were made arbitrarily even though during the observing activity, it was known that the side length was 100 cm, which caused errors to the final result. It is likely to occur because high school students can already critically analyze a problem so that they can interpret it in any way they think they can. Seeing this, the researcher gave provocation questions to students by asking them to re-observe the existing problems. The answers of students abilities can seen in Figure 5.



(a) (b)

Figure 5: The results of the answers of students with moderate abilities

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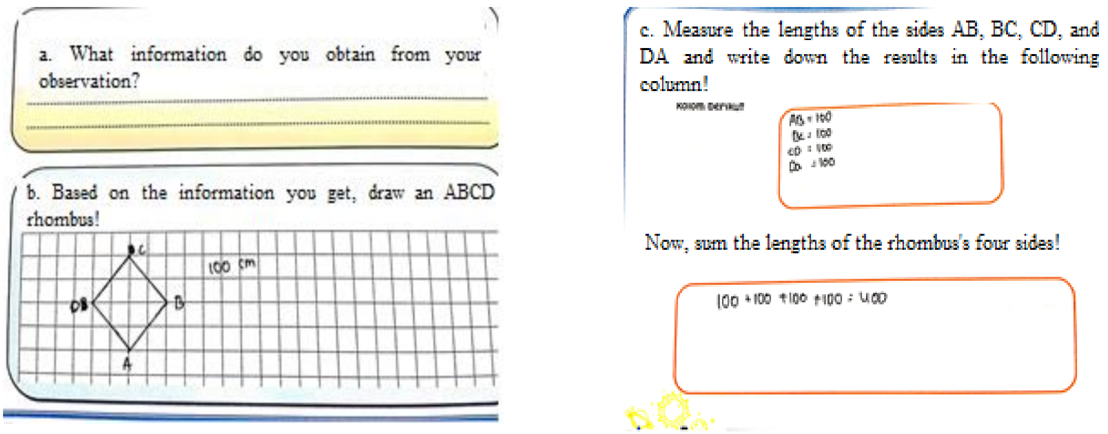
Based on Figure 5, in solving the problem, students with moderate abilities start by sketching the Rhombus in the problem, then determining the sides' length. In the results of the moderate ability, students' answers are correct, where the length of the sides then sorts the results of the sketch and the length of the Rhombus to get the circumference. Based on these activities, students also get a concept of the circumference and area of a rhombus. The results of the answers of students with low abilities can seen in Figure 6.



(a) (b)

Figure 6: The results of the answers of students with low abilities

Based on Figure 6, in solving the problem, students with moderate abilities start by sketching the Rhombus in the problem, then determining the sides' length. In the results, the answers of students with moderate abilities were correct. However, in the process, students only followed the instructions, so they did not find the concept of the perimeter of the Rhombus that they wanted to find.

Based on the student's answers, both those with high, medium, and low abilities, this problem can be solved because it is oriented towards an environment close to students, in this case, the *Rumah Gadang*. However, there are indeed mistakes in working on the questions. In the results of high-ability students' answers, it can be seen that there was a mistake in answering where the side lengths were made arbitrarily even though during the observing activity, it was known that the side length was 100 cm, which caused errors to the final result. It is likely to occur because high-level students can already critically analyze a problem so that they can interpret it in various ways that they think are appropriate so that they pay less attention to the steps involved. However, after being prompted, students can return to the problem correctly. Medium students immediately follow the steps to solve the problem and find the concept.

In the small group evaluation stage, the Ethnomatematics-based Hypothetical Learning Trajectory (HLT) of the *Rumah Gadang* topic of Rhombus was tested on 6 students, and each had high, medium, and low abilities, who were then grouped into two groups. The following results of students' answers are presented in the following figure. Problems on the HLT topic of finding the area of a rhombus can seen in Figure 7.

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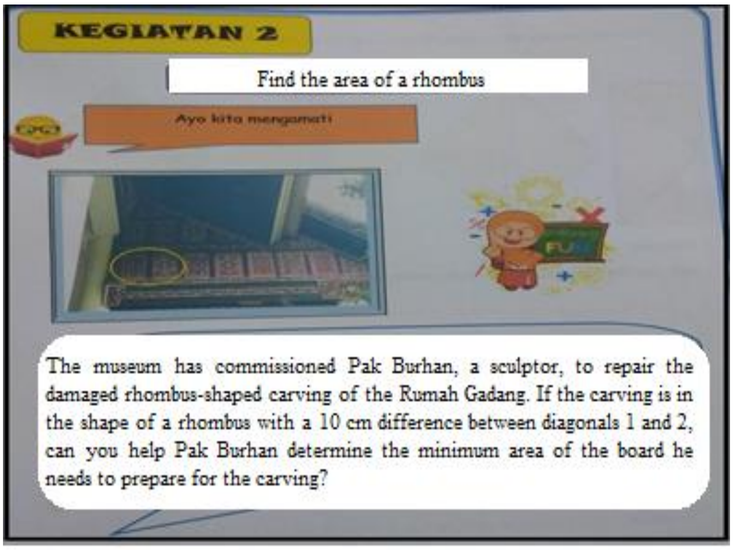
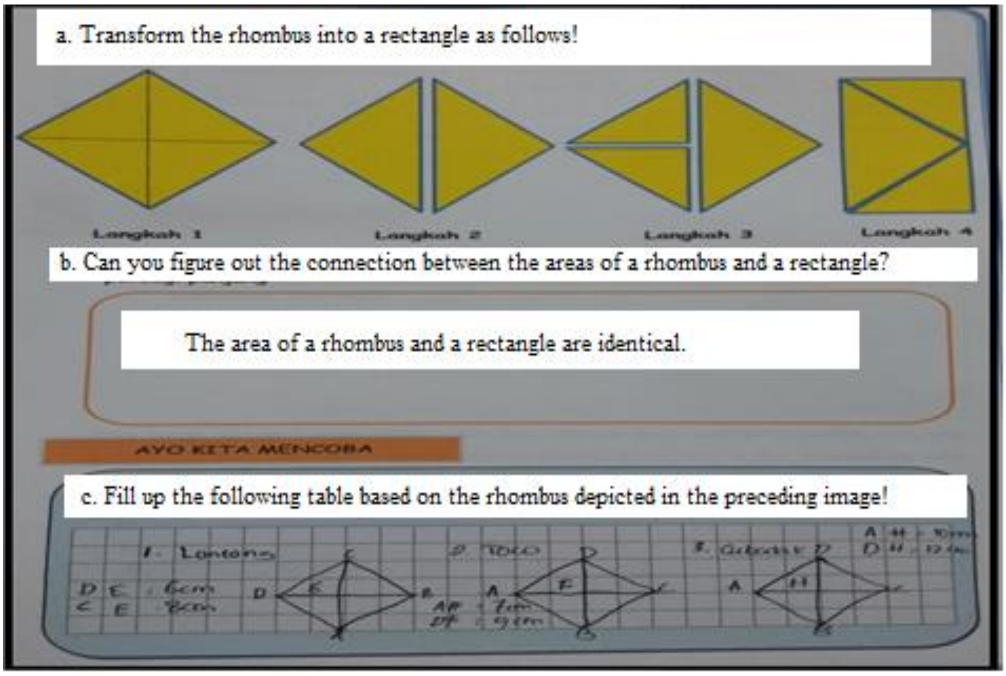


Figure 7: Problems on the HLT topic of finding the area of a rhombus

Based on Figure 7, the problems in HLT are made based on the results of exploration that has been carried out previously so that there is ethnomathematics integration in the problem. From the picture above, it can be seen that finding the area concept of a rhombus begins with the presentation of the ethnomathematics context of the *Rumah Gadang*. Then it is this context that students will use in the discovery process so that after following the steps in the HLT, students will be able to find the broad concept of a rhombus. When students solve problems in HLT, researchers observe what students do. The following are the results of student answers. Results of group 1's answers can seen in Figure 8.



(a)

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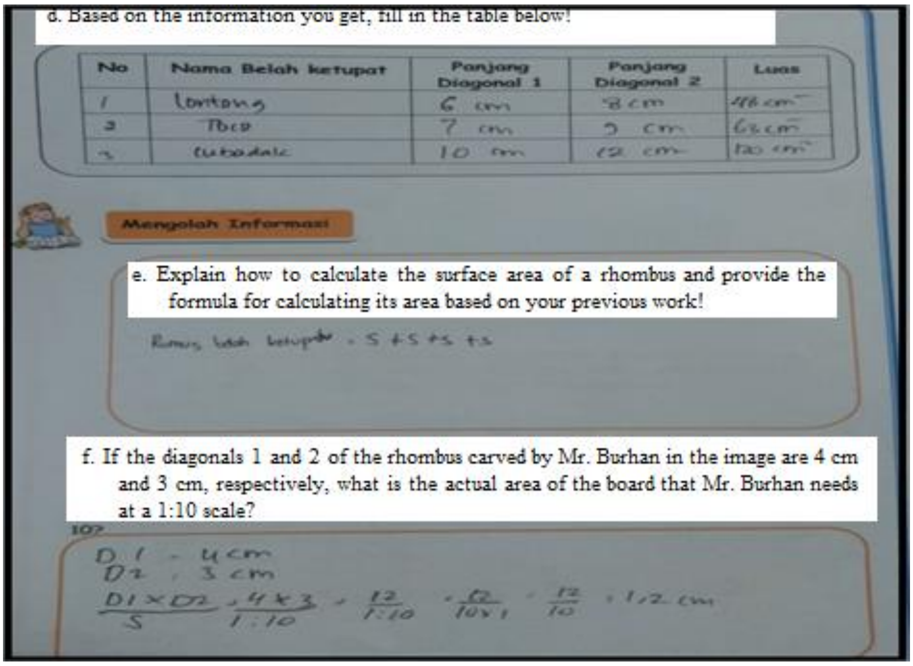
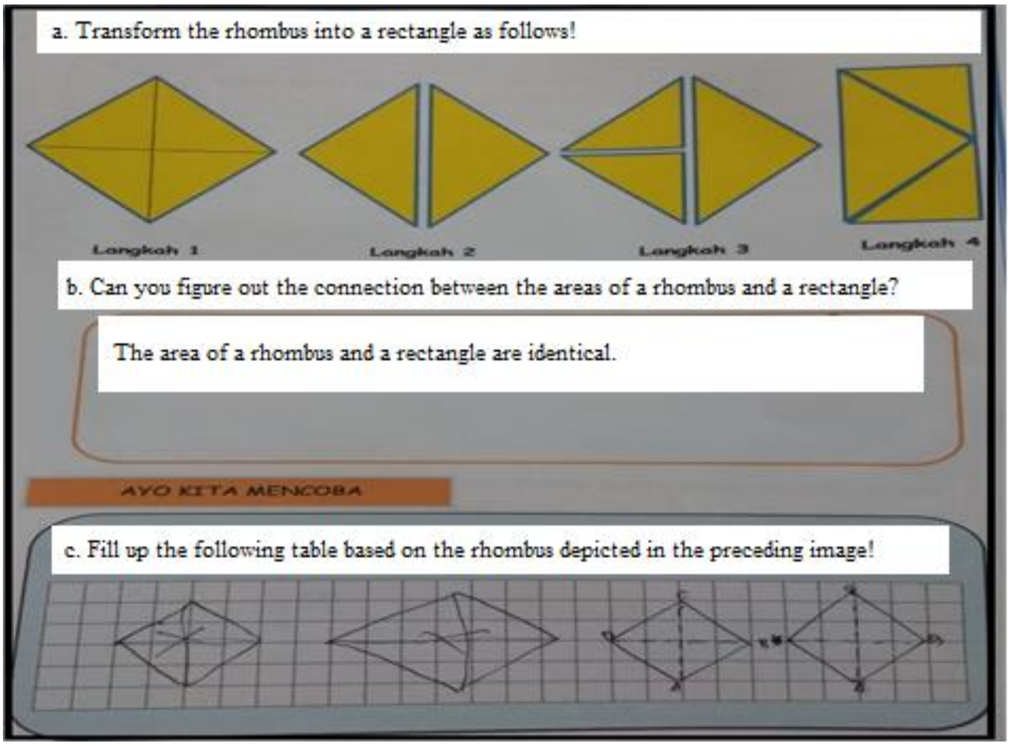


(b)

Figure 8: Results of group 1's answers

Based on Figure 8, in solving the problem, students start by sketching the Rhombus in the question, then determine the side lengths, followed by trying to find objects around that are similar to rhombuses. It is so that students' experience becomes rich in questions related to everyday life. In the results of the student's answers, it can be seen that the concept of the area of the Rhombus that they want to find has been obtained. Results of group 2's answers can seen in Figure 9.



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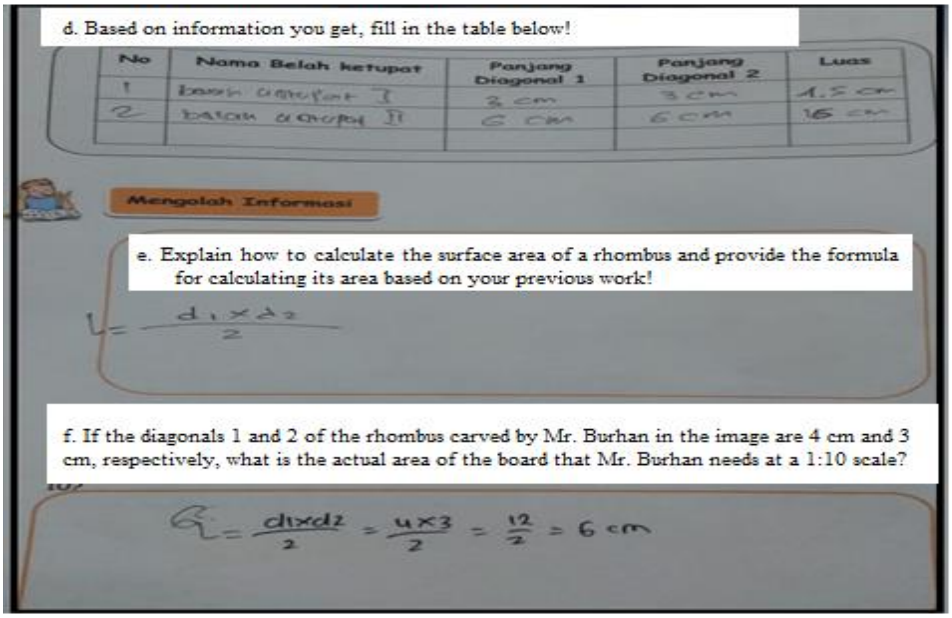

(b)

Figure 9: Results of group 2's answers

Based on figure 9, in solving the problem, students start by sketching the Rhombus in the problem even though it looks random and the length of the Rhombus is not precise, then continues by trying to find objects around that are similar to rhombuses. It is so that students' experience becomes rich in working on problems related to everyday life. In the results of the student's answers, it can be seen that the concept of the area of the Rhombus that they want to find has been obtained, but indeed the steps to find students have not been seen. Based on the three results of students' answers, the Hypothetical Learning Trajectory (HLT) based on Ethnomatematics at *Rumah Gadang*, the topic of Rhombus has led students to find the broad concept of Rhombus, based on observations during learning also shows that the ethnomathematics context in learning leads students to be more motivated and more active in learning because the context used directly interacts with their daily lives, but indeed based on observations in groups that work more are students with high and medium abilities but low students also observe and get an understanding of the results of the work.

CONCLUSION

Based on the research findings, it can be concluded that the Ethnomathematics-based Hypothetical Learning Trajectory (HLT) for the Rumah Gadang topic of Rhombus successfully guided students in discovering the concepts of the perimeter and area of a rhombus, demonstrating that the HLT is reliable and effective for the learning process. Observations during the learning sessions also indicate that the ethnomathematics context increases student motivation and engagement, as it directly relates to their everyday experiences.

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