Realistic Mathematics Education (RME) Approach to Material on the Characteristics of Two-Dimentional Figures Using the Reog Ponorogo Performance in Elementary Schools

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Abstract: It is critical to approach mathematical education correctly. This is because many students believe math is a tough subject to learn. This problem arises because many teachers teach mathematics in abstract terms. This is a qualitative descriptive study using Graveimeiijeir's design research method. The research was designed to prove the truth of the allegations made in the learning trajectory or HLT (Hypothetical Learning Trajectory) and their impact on students' understanding by applying the RME (Realistic Mathematics Education) approach to the material on the characteristics of two-dimensional figures, with Reog Ponorogo performance media and worksheet serving as a guide for student activities. This study was conducted on class 3B students at MI Ma'arif Darul Ulum Pondok. The research topic is a 6-student group in a classroom. The research stages included preparation, execution in the classroom, and data analysis. Based on this research, it can be seen that the stages of learning activities using the RME approach are based on the stages contained in the iceberg theory, namely, stages of real-world situations (situations), models that describe problem situations (model of), models for solving problems (model for), and formal mathematics stages using Reog Ponorogo performance media can make it easier for students to understand material regarding the characteristics of two-dimensional figures.

Abstrak: Pembelajaran matematika menggunakan pendekatan yang tepat penting dilakukan. Hal ini karena banyak peserta didik yang merasa matematika merupakan pelajaran yang sulit untuk dipelajari. Masalah itu muncul karena banyaknya guru yang mengajar matematika secara abstrak. Penelitian ini merupakan penelitian deskriptif kualitatif dengan metode penelitian design (*Design research method*) milik Graveimeiijeir. Penelitian dirancang untuk membuktikan kebenaran dugaan yang telah tertulis dalam lintasan pembelajaran atau HLT (*Hypothetical Learning Trajectory*) serta pengaruhnya terhadap pemahaman peserta didik menggunakan pendekatan RME (*Realistic Mathematics Education*) pada materi ciri – ciri bangun datar menggunakan media pertunjukan Reog Ponorogo serta LKPD yang menjadi pedoman aktivitas peserta didik. Penelitian ini dilakukan dengan subjek penelitian peserta didik kelas 3B MI Ma'arif Darul Ulum Pondok. Subjek penelitian yaitu salah satu kelompok di dalam kelas yang beranggotakan 6 peserta didik. Tahapan penelitian dilakukan yaitu perencanaan, pelaksanaan di dalam kelas, dan analisis data. Berdasarkan penelitian ini dapat diketahui bahwasannya tahapan – tahapan aktivitas pembelajaran dengan pendekatan pendekatan RME berdasarkan tahapan yang terdapat pada teori gunung es yakni: tahapan situasi dunia nyata (*situations*), model yang menggambarkan situasi permasalahan (*model of*), model untuk menyelesaikan masalah (*model for*) serta tahapan matematika formal dengan media pertunjukan Reog Ponorogo dapat memermudah peserta didik dalam memahami materi mengenai ciri – ciri bangun datar.

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A. Introduction

Education is a vital part of human life. Education is a human endeavour that can last a lifetime. Humans will readily develop with the education they are pursuing (Alpian et al., 2019). As a result, several countries have prioritized education in their development strategies. However, education will only produce excellent people if educational development is carried out properly.

Similarly, in Indonesia, there is still much progress in a better direction (Fitri, 2021). This is not just about developing information but also abilities (Afifah, 2017). Many areas need to be updated to improve education in Indonesia (Amelia, 2019). Elementary school education is an important level of education that should be considered.

All courses are taught at the elementary school level (Widodo, 2019). One of them is math. Mathematics was born and developed with humans' urge to systematize, forecast, and organize their future lives (Parnabhakti & Ulfa, 2020). Teachers should be able to assess their students' learning challenges in each topic. Every student has unique qualities. Math is a topic that many students fear (Yeni, 2015). This is because mathematics is abstract if it needs to be taught correctly or structured.

Mathematics is one of the most significant areas of science taught to students. Mathematics may help students become more communicative, logical thinkers, and problem solvers. Many students believe mathematics is a tough subject because they need help to answer the problems, even if mathematics is wider than that domain. This causes students to need to be more active in attempting to answer a mathematical problem (Anggraini, 2021).

Developmental theory is an important idea that should be examined in education. One of the most important disputes in developmental theory is on aspects of knowledge or cognitive development. This is one of the most significant components because it can help to build the others. Peaget's Cognitive Theory is one of the most famous theories (Rahmaniar et al., 2022). According to Piaget, students in elementary schools think at the concrete operational cognitive level (Marinda, 2020). This indicates that students can begin to reason at this point, but tangible or real objects must aid them. Teachers should be able to establish a learning environment in which students can gain direct experience. This will assist students in rational thinking and understanding the mathematical material offered (Agustyaningrum et al., 2022).

Mathematics is a vital subject in education, but many students dislike it. Thus, efforts to attain success in learning objectives are critical. Students must be encouraged to think logically, critically, and creatively when applying mathematics to real-world problems. This will assist students in improving their abilities to address challenges in their own lives. Given the current conditions, teachers must be savvy in picking the correct learning strategy that fits the topic (Sundawan, 2016).

RME (Realistic Mathematic Education) is one approach to mathematics learning that can help students develop their creative thinking skills. This paradigm mixes mathematics education with the realities of students' lives (Primasari et al., 2021). In this model, the

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teacher only guides students in constructively processing knowledge (Fitri, 2016). RME, as a learning model whose implementation is assisted by the provision of concrete media, will make it easier for students to construct abstract knowledge into reality in life (Setyawan, 2020). In other words, RME can help students construct their knowledge through activities based on the reality in their environment. This approach solves several problems described above (Khotimah & Asâ, 2020).

The RME strategy focuses on implementing mathematical learning and student activities in the classroom, which requires a learning trajectory, or what is commonly referred to as a learning trajectory. HLT, or Historical Learning Trajectory, is a learning method that encourages students to complete a sequence of specific exercises to understand the subject provided. HLT is a hypothesis or prediction based on students' experiences during learning (Anggraini et al., 2022). Mathematics learning carried out by developing plans or hypotheses in the form of HLT based on the RME approach will result in student-centered learning; students can also construct their knowledge gathered during the learning process (Rokhmawati et al., 2023). By linking learning with RME learning supported by HLT, it is hoped that learning mathematics will be easier and more enjoyable.

Based on the issues at MI Ma'arif Darul Ulum Ponorogo, specifically students' inability to define the features of two-dimensional figures appropriately, this research is necessary. Students only guess the characteristics of two-dimensional figures based on their names. The learner needs to grasp which section is being discussed. They only cited a few qualities that needed to be more accurate. Field studies show that even without classroom experience, students may understand learning content by memorizing it. Differences in student characteristics and the level of difficulty of the subject determine the learning that should take place in the classroom, ensuring that students gain a real comprehension of the material.

Fatmahanik (2018) previous research, "Mathematics learning in Reog Ponorogo culture (Ethnomathematics Study)," demonstrated what mathematical principles are in Reog Ponorogo's performance. Beginning with dancing equipment, musical instruments, and other performing equipment. This study did not describe the deployment of ethnomathematics-based learning in the classroom. So, this is a unique study since it uses thematics-based learning to improve Reog Ponorogo's performance by applying HLT in learning to recognize the characteristics of spatial shapes. This discovery is vital for making mathematics learning more exciting and easier to understand.

Based on the preceding, the purpose of this study was to demonstrate the validity of the assumptions made in the learning trajectory or HLT (Hypothetical Learning Trajectory) and their impact on students' comprehension by applying the RME (Realistic Mathematics Education) approach to the material on the characteristics of two-dimensional figures using Reog Ponorogo performance media and worksheet, which serve as guidelines for student activities.

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B. Method

This is a qualitative descriptive study using a design research method. It was conducted on class 3B students at MI Ma'arif Darul Ulum Pondok. There are 28 students in this class. Meanwhile, one of the class groups serves as the research subject, with six students as subjects. Various sources of classroom activities were collected, including images, films, interviews, and observations of students' activities in examining the features of two-dimensional figures with Reog Ponorogo performance tools.

According to Gravemeijer & Cobb (2006), the research stages begin with research preparation activities and initial research design with the process of creating worksheets and HLT, followed by implementing the experimental design that has been created by conducting worksheet and HLT experiments in the classroom, and which The last stage involves reviewing data gathered from previous phases, specifically data derived from students' worksheet, as well as the outcomes of observations and interviews. The worksheet developed by researchers attempts to assess students' cognitive abilities at level C2, namely explaining, and psychomotor characteristics at level P3, namely demonstrating. This study will provide a descriptive explanation of the findings acquired during classroom exercises.

This study analyzed HLT (Hypothetical Learning Trajectory) to determine the features of multi-sided flat structures. The exercise involved presenting Reog performance equipment as one of the students' learning mediums that may be integrated into mathematical knowledge. The development of HLT is based on a literature review, past research findings, and understanding students' challenges and impediments while learning in the classroom. The HLT design results are then shown in the HLT table, which includes the teacher's actions, the scenario based on the iceberg analysis outlined in the worksheet, and the purported activities carried out by students in response to the teacher's stimulus.

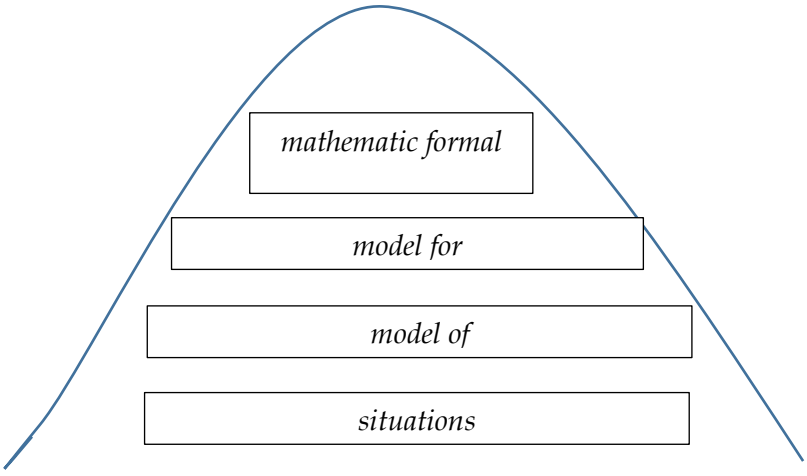

Figure 1. Illustration of *Iceberg* RME

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Meanwhile, HLT is presented in the column below:

Table 1. Hypothetical Learning Trajectory (HLT)

Activity	Level	Alleged Learning Process
Students read literature about the Reog Ponorogo performance.	Situations	Students understand the reading about the Reog Ponorogo performance. Students also observe several shapes in the pictures in the reading.
Students observe the images presented in the worksheet.	Model Of	Students can find any two-dimensional figures in the dance and musical equipment at the Reog Performance.
Students are given the command to count the number of sides of the Udheng	Model For	Students can determine the number of sides in an udheng and write them in letter form.
Students are given the command to calculate the number of udheng angles.		Students can determine the number of udheng angles and write them in letter form.
Students are given the command to measure the udheng angle using a protractor.		Students can find the size of the udheng angle and write it in degree form.
Students are given instructions to fold the udheng into several folds that produce the same fold.		Students can determine the number of fold symmetries in the udheng.
Students are commanded to rotate the udheng several turns to produce the same shape.		Students can determine the number of rotational symmetries in the udheng.
Students are given instructions to observe the image and find the characteristics of the two-dimensional figures found in the image.		Students can complete the table by counting the number of sides, angles, and folds of symmetry discovered.
Students can identify the rectangular, triangular, and polygon two-dimensional figures in the Reog Ponorogo performance.	Formal	Students can draw conclusions based on the characteristics of rectangular, triangular, and multi-sided two-dimensional figures shown in the Reog Ponorogo performance.

C. Result and Discussion

Result

Researchers designed the activities into four activities. Before the activity began, the researcher divided the students in the class into five groups, each group consisting of 5 - 6 students. The four activities designed include a situation in the form of an activity of finding two-dimensional figures in a Reog performance, a Model in the form of an activity to describe any two-dimensional figures that have been found, a Model in the form of an activity of describing two-dimensional figures using udheng and other equipment, and formal mathematics in the form of a conclusion drawing activity.

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Activity 1

At the start of the lecture, the teacher asks the students what flat figures they already know. The teacher assesses the participants' understanding of two-dimensional figures and their features. The next exercise begins once the teacher has collected the necessary information. This project involves students reading books on Reog Ponorogo. The reading also includes graphics and animations to help students grasp it. Students began to notice distinct two-dimensional figures on the surfaces of various dance and gamelan instruments utilized in Reog performances. Most students can read well. However, one kid was still learning to read, so the teacher had to assist him in understanding the material. Students are already familiar with numerous two-dimensional figures. The following is an excerpt from a discussion held between teachers and students:

Teacher: "Students, do you know Reog Ponorogo?"
Students:" I know, ma'am, I often see it every time there is a show."
Teacher: " Okay, students, try reading the text about Reog Ponorogo first!"
As an introduction to Reog Ponorogo, students are asked to read a reading text provided by the teacher.

Figure 2. Reog Ponorogo Reading Text Worksheet Page

After the students understand the reading text, the teacher ties Reog Ponorogo to their knowledge of two-dimensional figures. Then, the following conversation happened:

Teacher:" Do you know about two-dimensional figures?"
Students:" Yes, Ma'am."
Teacher:" Two-dimensional figures, whatever you know?"
Students:" Triangle, rectangle, square, circle."
Teacher: "Come on, Students. Please observe the reading on the worksheet and find out what two-dimensional figures are there!"
Students:" Ma'am, there are several pictures with many two-dimensional figures, ma'am."
Teacher:" Come on, Students, try to find what two-dimensional figures are in the photos?"

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Figure 3. Pictures That Students Need to Observe

In activity 1, it was discovered that students only understood a few basic structures and their basic characteristics.

Activity 2

In this activity, students investigate two-dimensional figures in photographs of Reog Ponorogo equipment. After discovering two-dimensional figures, students can describe them on the worksheet. The following is the conversation that occurred:

Teacher:" You can describe any images you find next to the photos provided!"
Students:" Ma'am, I found several forms here. Are they all drawn?"
Teacher:" Yes, please describe everything. The teacher wants to ask what structures there are in this Udheng."
Students: "Square and triangle, ma'am."
Teacher:" Wow, that is great. Try describing it on that page!"

Figure 4. Drawing Process

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Some of the accessible images demand in-depth study to discover two-dimensional figures; thus, the teacher assists the students in finding and describing them on the provided worksheet.

Figure 5. The Results of the Students' Findings Have Been Described in the Worksheet

Based on the outcomes of the preceding work, students in groups may identify many two-dimensional figures in an image. The majority of the graphics exhibited agree with the existing two-dimensional figures. Students employ drawing equipment such as a ruler, compass, and pencil. They are quite passionate about the procedure. Students in groups collaborate by providing numerous thoughts and comments to the group.

Activity 3

The activity consists of a series of activities designed to discover previously recognized features of two-dimensional figures. Teachers use concrete material in the form of Udheng to help students identify the characteristics of square two-dimensional figures and various photographs are presented to assist students in identifying different two-dimensional figures.

Figure 6. Students Spread Udheng

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The image above shows students stretching Udheng. Udheng is used to assist students in understanding the features of flat square shapes. Students are asked to observe each udheng assigned by the teacher. Students count the sides of the Udheng. Before counting, the teacher asks where the Udheng's sides are. Students present it and quickly count the number of sides it has. The following is a conversation that happened during this activity:

Teacher: "Students, try to look at this Udheng, see what is depicted in it?"
Students: "Square, ma'am."
Teacher:" Come on, students, I want to know which side Udheng is?"
Students:" This one, this one, this one, and this one, ma'am."
Teacher:" Great, let us count how many there are."

Students are then asked to locate the corner points and tally how many corner points Udheng has. The teacher begins by asking which section is called the corner point. Students can demonstrate which corner point of the Udheng is. Students were able to locate corner locations on Udheng based on observations made by the teacher. Students can also determine how many corner points makeup Udheng. The following is the conversation that occurred:

Teacher:" Come on, students, try to find out which ones are called corner points?"
Students:" This one, ma'am." At the same time, showing which part they know is the corner point.
Teacher:" Yes, that's right. It's a corner point. So what does corner point mean?"
Students: "Meeting, ma'am."
Teacher: "What meeting?"
Students:" Line meeting."
Teacher:" A corner point is the intersection of two or more lines or sides."

Figure 7. Students Determine the Number of Angles They are Using

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The following activity requires students to use the bow they brought to measure the size of the udheng's corner points. Since they have yet to gain prior knowledge, students need help measuring the udheng angle. The teacher first instructs students on how to use a bow. Then, students can independently determine the size of the udheng's corner points. Students can observe that the corner points of an arc are the same size, namely 90 degrees. The following is the conversation that occurred.

Students:" Ma'am, how do I measure it?"
Teacher:" Look, son, try to pay attention to your mother. Place the bow at a point. Adjust it well until the baseline of the bow is in the right position (coincides) at one corner of the corner leg. Then measure the angle starting from 0 degrees, which is located on that line, until it reaches another line that borders it."
Students: "Okay, ma'am."

Figure 8. Students Measure the Size of the Udheng Angle

In the following activity, students use Udheng to determine the number of lines of symmetry in a flat square shape. Fold the Udheng into equal pieces. Students can find four-fold symmetries in udheng. Before the students begin folding, the teacher explains that folding symmetry is achieved by folding the adhering until equal sides form on all sides of the piece. Students attempt to find folding symmetry by following the instructions given by the teacher previously. The teacher assists students who are having difficulty identifying fold symmetry. The following is a snippet of the conversation that occurred:

Students:" Ma'am, what is folding symmetry, ma'am?"
Teacher:" You will get folding symmetry when you fold the Udheng until you find the same side on both pieces of the folded Udheng. Come on, try folding. Both sides of the fold must be the same!"

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Figure 9. Students Fold Udheng to Find How Many Lines of Symmetry There Are

The last Udheng exploration activity requires students to determine the number of rotational symmetries in Udheng. Students can rotate Udheng until it forms the same shape, a square. Students can find four rotational symmetries in Udheng. Before the students try to rotate, the teacher explains that they will achieve rotational symmetry if they rotate the udheng till it resembles the original shape. They appeared excited about carrying out this task. They appeared to be quite intrigued about what was going on. The following is the conversation that occurred:

Student:" Ma'am, how do you find rotational symmetry?"
Teacher:" The way to do this is by rotating the udheng. Try rotating the Udheng until it returns to its original shape. Then count how many times it can be rotated to produce its original shape!"

Figure 10. Students Fold Udheng to Find How Many Rotational Symmetries There Are

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The final activity in the third activity is to identify two-dimensional figure features using the worksheet's images. The teacher urges students to look at images of equipment. The teacher instructs students to investigate the characteristics that make up the two-dimensional figures they discover. The teacher instructs them to create udheng in the shapes illustrated in the photograph. After that, experiment with the number of sides, corner points, and fold symmetry using the adjusted udheng. The following is the conversation that occurred:

Teacher:" Come on, kid, see if you can shape the udheng according to the two-dimensional figures you found in the picture?"
Students:" Yes, ma'am, like this, ma'am?"
Teacher:" Yes, that's right. Come on, try to pay attention and count the number of sides, corner points, and lines of symmetry!"
Students:" Ma'am, how is this ma'am?"
Teacher:" If you have difficulty, let's try folding the Udheng you had earlier into a two-dimensional figure that you want to describe! Then, find the characteristics."

Figure 11. Students Write Down Their Findings Regarding the Characteristics of Two-Dimensional Figures Using the Pictures Provided

At this step, students face several challenges in the description process. For this reason, the teacher instructs students to fold Udheng into flat forms, rectangles, triangles, and trapezoids and then to perform activities similar to the preceding activity to determine the number of sides, corner points, and folded symmetry. With activities like this, students can learn how to fold in order to create the desired two-dimensional figures and more quickly identify the characteristics of the two-dimensional figures they find.

Activity 4

During the last activity. The teacher instructs students to conclude what two-dimensional figures they discovered during the session and characterize the qualities of each two-dimensional figure found. Students can state the qualities of two-dimensional

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figures in succession based on the knowledge they have gained during the various stages of the activity.

Figure 12. The Teacher Directs Students to Write Conclusions

Discussion

Based on the results of learning activities, it is known that the learning steps and activities undertaken by students are consistent with the HLT (Hypothetical Learning Trajectory). Students can follow the worksheet and the teacher's directions correctly and coherently, allowing them to construct knowledge more easily. Similar to what (Warsito et al., 2019) explained, the RME approach used consists of a series of stages of research activities that become the main reference in each learning activity, and the design of learning or research activities is guided by the characteristics of RME, namely starting with the use of context at the beginning of learning, which aims to increase students' motivation and interest in learning.

This can also be measured by the outcomes of teacher observations in class; prior to the session, students could only identify a few basic characteristics of two-dimensional figures. Meanwhile, after learning is completed, students may properly articulate the characteristics of the two-dimensional figures they have learned. They can also understand new concepts related to two-dimensional figures' characteristics, such as fold and rotational symmetry. This is also consistent with a study conducted by (Primasari et al., 2021), which states that learning activities using Realistic Mathematic Education (RME) with media can take students from abstract situations to more real (concrete) situations.

D. Conclusion

Based on this research, it is clear that the RME technique based on the Reog Ponorogo performance media can help students understand content about the characteristics of two-dimensional figures. A learning trajectory that begins with situational activities, such as text

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and image observation, progresses to the Model of activities, such as described, then the Model for activities, such as carrying out characteristics search activities, and concludes with formal activities, such as concluding all completed activities. Students can discover the features of two-dimensional figures utilizing real-world experience in the classroom.

The RME approach, with concrete learning media in the form of images supplemented by student activities via the worksheet, greatly aids students in developing their knowledge of the features of two-dimensional figures.

Several aspects should be highlighted during the research, including the need for clarity in teacher and worksheet directions to students. Aside from that, teachers must pay attention to several aspects that students require, such as their initial knowledge and various talents. So that classroom activities can be created with this in mind. The researcher's drawback is that he only covers the design for implementing the RME approach in the material on the features of two-dimensional figures in class 3B using the Reog Ponorogo performance. Hopefully, future studies will result in usable RME materials and media.

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