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Learning Rotation using the Context of Palembang Songket Fabric Motif for 3rd Grade Secondary School

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Abstract

Rotation is an essential part of geometric transformations. This research aims to produce a learning trajectory of rotation material and determine the role of activities in learning the rotation which is expected to be able to support students understanding the concept of rotation learning in grade IX. The approach used is Pendidikan Matematika Realistik Indonesia (PMRI) with Lesson Study for Learning Community (LSLC) as learning system. The method used in this research is a design research type validation study. This research was conducted in limited face-to-fece meetings at secondary school number 1 Palembang during the pandemic and involved 13 students of class IX. The data were collected using video recordings and photos taken during the learning process, student interviews, student work, discussion results, and field notes at each meeting. The results of this study indicate that the learning trajectory can support the informal to formal concept of rotation, including the activity of recording the starting point and endpoint, analyzing and interpreting changes of starting and endpoints using one's language, and writing the rotation formula. Therefore, it can be concluded that a series of activities by exploring the Palembang songket fabric motif plays a role in helping students understand the concept of rotation easily and allows them to produce rational imaginations and fun learning.

Keywords: Palembang Songket Fabric Motif, PMRI, Rotation, Design Research

Abstrak

Rotasi merupakan salah satu bagian penting dari pembelajaran transformasi geometri. Penelitian ini bertujuan untuk menghasilkan lintasan belajar materi rotasi dengan konteks motif kain songket Palembang dan mengetahui peran motif tersebut dalam membantu pemahaman konsep siswa terhadap materi rotasi. Pendekatan dalam penelitian ini adalah PMRI yang dikombinasikan dengan LSLC sebagai sistem pembelajaran. Metode yang digunakan dalam penelitian ini adalah *design research* tipe *validation study*. Penelitian ini dilaksanakan di SMP Negeri 1 Palembang dengan melibatkan siswa kelas IX yang berjumlah 13 siswa. Data yang dikumpulkan berupa rekaman video dan foto selama proses pembelajaran, wawancara siswa, hasil kerja siswa, hasil diskusi, dan catatan lapangan pada setiap pertemuan. Hasil penelitian ini menunjukkan bahwa lintasan pembelajaran dapat mendukung konsep rotasi informal ke formal, termasuk aktivitas mencatat titik awal dan titik akhir, menganalisis dan menginterpretasikan perubahan titik awal dan akhir menggunakan bahasanya masing-masing, dan menuliskan formula rotasi. Oleh karena itu, dapat disimpulkan bahwa rangkaian kegiatan dengan mengeksplorasi motif kain songket Palembang berperan dalam membantu siswa memahami konsep rotasi dengan mudah dan memungkinkan mereka menghasilkan imajinasi yang rasional dan pembelajaran yang menyenangkan.

Kata kunci: Motif Kain Songket Palembang, PMRI, Rotasi, *Design Research*

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INTRODUCTION

Rotation is one of four fundamental forms of transformation. It is a transformation that re-aligns all points with the points in the plane using an angle's center point by rotating these points to the rotation's center point (Maryati & Prahmana, 2019). Rotation can also define as a transformation that

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matches all points in the plane again with the points in the plane with the help of a center point and angle (Martin, 1982). The rotation's parameters are the center and angle (Zembat, 2013).

Learning rotation is necessary to for understanding trigonometry (Gurbuz & Durmus, 2009). Through rotational learning, students can connect several geometric concepts, such as congruency and equivalence (Panorkou & Maloney, 2015). Rotational learning can be a foundation for students' geometric understanding because of its dynamic nature so that it opens opportunities for students to associate this concept with other geometric concepts such as congruence and equivalence (Panorkou & Maloney, 2015).

Unfortunately, students still have many challenges in learning rotation. The results of interviews and observations at secondary school number 1 Palembang show that the students frequently have difficulties to master geometric transformations, particularly rotation because the teacher used practical formulas and has not connected mathematical concepts with students' daily activities. In other words, the rotational learning in the classroom has not utilized a particular context. Students have difficulty in visualizing the outcomes of a plane's rotation. In addition, they cannot generalize that the rotation of point A(x,y) in a particular direction will result in image A' (x,-y). The same problem also occurs in the international context in which students have difficulty in understanding the concepts and variations raised in identifying rotational transformations (Guven, 2012). Moreover, they have difficulty identifying the direction of rotation and imagining how to manipulate the rotation of a geometric object with a more complex shape (Paulsen & Morris, 2011). Therefore, educators should teach geometric transformations using clear images because students can more easily discover the properties of shadows through visual transformations with the assistance of images more easily than when they do not use images (Bansilal & Naidoo, 2011).

Therefore, it is necessary to innovate a mathematics teaching approach to create more meaningful learning. One of the innovative approaches is Pendidikan Matematika Realistik Indonesia (PMRI) approach, adapted from Realistic Mathematics Education (RME) and developed following real context, cultural values, and local wisdom of Indonesia (Sembiring et al., 2008). The PMRI is a learning approach that emphasizes the real-world context students can found in student’s life (Zulkardi, 2002). Teaching geometric transformations using PMRI helped students understand and develop concepts. According to Zulkardi (2002), many students could more effectively express their opinions and, most importantly, independently solve problems of geometric transformations.

PMRI employs the context as the learning process's starting point (Putri & Zulkardi, 2019). One familiar context for students is the cultural context. The link between mathematics and culture offers students the opportunity to engage in multicultural mathematical activities and understand individuals' behavior and knowledge from diverse cultural backgrounds (D'Ambrosio, 1990). Learning mathematics within a cultural context allows students to interpret mathematics, demonstrate the accuracy of mathematics and other cultures, and motivate students to learn mathematics collaboratively and enthusiastically (Mayadiana, 2009). Rotational learning can utilize easily accessible local contexts from the student's environment, such as culture (Risdiyanti & Prahmana, 2018). As a result, the students will easily solve problems encountered in everyday life.

This study used the Palembang songket fabric motif context as a starting point to learn rotational geometry transformation. This context was chosen because it is accessible and relevant to students' daily lives. Ultimately, this context is a part of student culture. The geometric shapes in Palembang songket fabric motif can serve as a context to rotate a point, line, or plane.

Sari and Putri (2021) have found that learning mathematics using cultural context, particularly Palembang culture, can increase students' understanding, learning motivation and interest by connecting concepts studied in the classroom to real-world situations. These findings are like those of research by Thaqi and Gimenez (2011), which has discovered that the use of images helps educators teach transformation geometry more effectively. He argued that the students can find at-shadow properties transformation through visuals to study transformations. Therefore, it is believed that the Palembang songket fabric motif can be used as a context to learn rotation.

The development of the Kurikulum Merdeka is supported by various national policies, including 21st Century Competence (4C’s). The 4C’s, which consists of communication, collaboration, critical thinking, and creativity, is used to improve the quality of 21st-century education (Rahmawati, 2016). The collaboration strategy can be applied through a system of Lesson Study for Learning Community (LSLC). LSLC can improve the quality and significance of learning (Arifin, 2017; Putri, 2012). Moreover, learning through LSLC fosters an environment conducive to learning through dialogue and communication and inspires and connects students to construct diverse learning situations (Sato, 2014).

Putri and Zulkardi (2019) argue that implementing LSLC enables students can collaborate to solve jumping tasks, which are complex problems. LSLC can also enhance students' mathematics skills, including their reasoning abilities (Octriana et al., 2019). This research designs learning using research design, PMRI, and LSLC as a learning system. Putri and Zulkardi (2019) explains that combining lesson study and design research can improve students’ collaboration, thereby making mathematics learning meaningful and straightforward. Students with high ability could complete the jumping task, but students with low achievement have difficulty. However, collaborative learning using the learning culture "please teach me," enables the students with difficulties in mathematical concepts to finally complete the jumping task with HOTS question categories (Putri & Zulkardi, 2019). Therefore, the researcher designed this study which used design research, PMRI, and lesson study.

In addition, some researchers have designed mathematics learning using PMRI approaches and cultural contexts, such as learning geometry and values using batik patterns of yogyakarta (Prahmana & Ambrosio, 2020), learning number patterns using “Barathayudha” war stories (Risdiyanti & Prahmana, 2020), learning design on rotation material using kawung batik motifs (Risdiyanti & Prahmana, 2018), learning design on transformation using Sidoarjo written batik motifs (Lestariningsih & Mulyono, 2017). This study used Palembang songket fabric motif as the context on learning rotation. This context was chosen because it is easy to find in students' daily lives and there has been no other research related to rotation using the context of Palembang songket fabric motifs. In addition, this research also highlights the learning process using PMRI and LSLC. Therefore, this study aims to determine the role of activities in learning rotation, which is expected to be able to help students understand the concept of rotation and the origins of the formula.

METHODS

This research employed a validation study design with three stages: preparing for the experiment, conducting the experiment, and completing a retrospective analysis (Gravemeijer & Cobb, 2006; Putri & Zulkardi, 2017). This research involved 13 students of 3rd grade at secondary school number 1 Palembang. When preparing the experiment, the researcher and the teacher model designed a learning trajectory using the Palembang songket fabric motif, included in the student worksheet, lesson plan, grids, teacher instructions, observation sheet, and student answer predictions.

The design research stage was then combined with the LSLC stage. The preliminary design stage refers to the ‘plan’ stage; the teaching experiment stage refers to the ‘do’ stage and the retrospective analysis stage refers to the ‘see/reflection’. The initial design, comprised interviews, observation, and a process of designing a hypothetical learning trajectory. The designed HLT was tested in a pilot experiment, then a retrospective analysis was performed. The results of this analysis contributed to revise the HLT and provide an applicable instrument to the teaching experiment. The process of learning activities was re-analysed to improve to the HLT which would become the learning trajectory.

Based on these preparations, the researchers and the teacher model created two activities. The objective of the first activity was to enable the students to determine the definition and properties of rotation of an object based on contextual problems. Meanwhile, the objective of the second activity was to enables the students to determine the shadow coordinates of rotated objects, as well as the relationship between the starting and ending points of a rotation with an angle of 90^0, 180^0, and 270^0 when drawing the Palembang songket fabric motif.

The experimental stage consisted of a pilot and teaching experiments. The students are appointed based on the mathematics teacher’s suggestions and the students’ math scores. They were divided into three groups of three mathematics levels (high, middle, and low) by adjusting the cross-section seats between male and female students.

The next step after the experimental stage was the retrospective analysis stage. The researchers, model teachers, and observers reflected on the lesson to identify the strengths and weaknesses of implementing the learning design. Then, their comments and suggestions were used to improve the quality of learning without offending the model teacher, as reflected in the students’ learning process and the effectiveness of the designed and implemented teaching materials (Putri & Zulkardi, 2019; Utami & Nafi’ah, 2016).

The data were analysed descriptively by observing and reviewing documents in a student worksheet. The researchers used the observation to view the students' behavior, such as reactions, attitudes, facial expressions, interaction processes, and communication. Meanwhile, the document review in a student worksheet, consisted of a sharing task and a jumping task (Putri & Zulkardi, 2019; Sato, 2014).

RESULTS AND DISCUSSION

This research produces a learning trajectory for rotation material using the PMRI approach and implements the LSLC. The learning trajectory was created to help students understand the concept of rotation. This study went through three stages: the preliminary design, the teaching experiment, and the retrospective analysis. In addition, this study employed the LSLC learning system, which consists of three stages: planning, doing, and seeing (Sato, 2014). The design research stage was then combined with the LSLC stage; the preliminary design stage refers to the plan stage; the teaching experiment stage refers to the do stage; and the retrospective analysis stage refers to the see stage.

This lesson was designed to investigate the role of the Palembang songket fabric motif through the designed activities to help students learn rotational learning. This article focuses on the teaching experiment tested on 15 students during the COVID-19 Pandemic. This lesson aims to understand the concept of rotation and explore students' reasoning abilities through the established activities. The learning trajectory in rotational learning includes (1) understanding the definition and the characteristics of rotation; (2) finding the relationship between the starting point and the endpoint of the rotation results; (3) concluding the mathematical relationship found in the process of drawing Palembang songket fabric motif with a rotation formula for a point-to-point O (0,0) with a rotation angle of 90^0,180^0 and 270^0, and (4) solving rotation problems in everyday life related to rotation.

The PMRI approach, a series of activity sequences, and several rotational learnings were the primary references in each learning activity carried out in each cycle. The learning process applied the Palembang songket fabric motif to start the material on the definition of rotation. The activities show that the students explore prior knowledge through activities using the Palembang songket fabric motif to determine the definition and nature of rotation, find the relationship between before and after the rotation, and solve rotation problems in daily life.

Students are very enthusiastic about working on each question on the activity sheet and using the product packaging provided during the learning process. The design of this activity refers to five characteristics of PMRI: learning must begin with the use of context, to increase students' learning motivation (Wijaya, 2012). Before and after conducting a series of learning activities, students had a pretest and post-test. The researcher obtained information from these two tests that the students demonstrate various work results of understanding rotation in the pre-test and the post-test. Moreover, the designed activities have enabled the students' knowledge to increase and solve rotation problems.

The result of the retrospective analysis show that many students could not answer most of the questions in the pretest. In contrast, they have been able to solve various rotation problems in the post-test. At the end of the activity, some students could more significantly express their reasoning. This finding concludes that students' knowledge and thinking skills regarding rotation problems have increased.

The First Meeting: Determine the Definition and Properties of Rotation

The learning began with the student's sitting position, which forms the letter "U" to enable the teacher to see all the students' activities. Before starting the class, the teacher greeted the students. Then, he checked the students' attendance and asked about their readiness to take part in the lesson. As an apperception, the teacher asked the students whether they still remember the examples of rotating objects. Afterward, he conveyed the learning objectives and asked students to pay attention. The students were very enthusiastic about learning during the "do" stage; only one or two of them did not understand the experimental situation. At the beginning of the lesson, the teacher asked the students to exemplify rotation in real life by asking the following questions.

Teacher : *Can anyone exemplify rotational motion?*
Student : *The wheels of a moving vehicle*
Teacher : *That's right, the spinning wheel. What else?*
Student : *The motion of a clock*
Teacher : *Good. What else?*
Student : *Motion of the moon around the earth*
Teacher : *Right. What else?*
Student : *Fan moving in the house, table fan and blender's blade motion*
Teacher : *Yes, those are the correct examples. Now can anyone conclude the definition of rotation?*
Student : *It is a movement*
Teacher : *Can anyone explain it more clearly?*

In mathematics class using the PMRI approach, the teacher should not say the concept of rotation before the students collect data. Thus, they could construct knowledge by interpretating the data around them in the form of tangible objects. Consequently, the students' involvement in finding concepts independently could increase.

Figure 1. Classroom seating arrangements in learning

During core learning, the students studied in groups. As seen in Figure 1, students were divided into three groups, and each group consisted of four students, with two men and two women. Because the number of the students was odd, one group comprised five people. Afterward, the teacher distributed sharing task, which consisted of five questions. The teacher instructed them to read the work instructions, then he informed the students to collaborate with their friends if they have any trouble by writing "*Ask for Help*" on a note. Afterward, the teacher gave the students 15 minutes to work on sharing task. The sharing task in the first meeting, discussed the problem of the Palembang songket fabric motif process. This motif was attributed to the concept of rotation on two-dimensional figures. The concept of rotation was applied by rotating the patterns following the axis. Rotation was applied on a specific axis with the same length as the figure that would be rotated, allowing each point in the desired figure to be rotated. Despite being rotated, the size of the Palembang songket fabric motif was not altered at all. The questions on the sharing task are as follows in Figure 2.

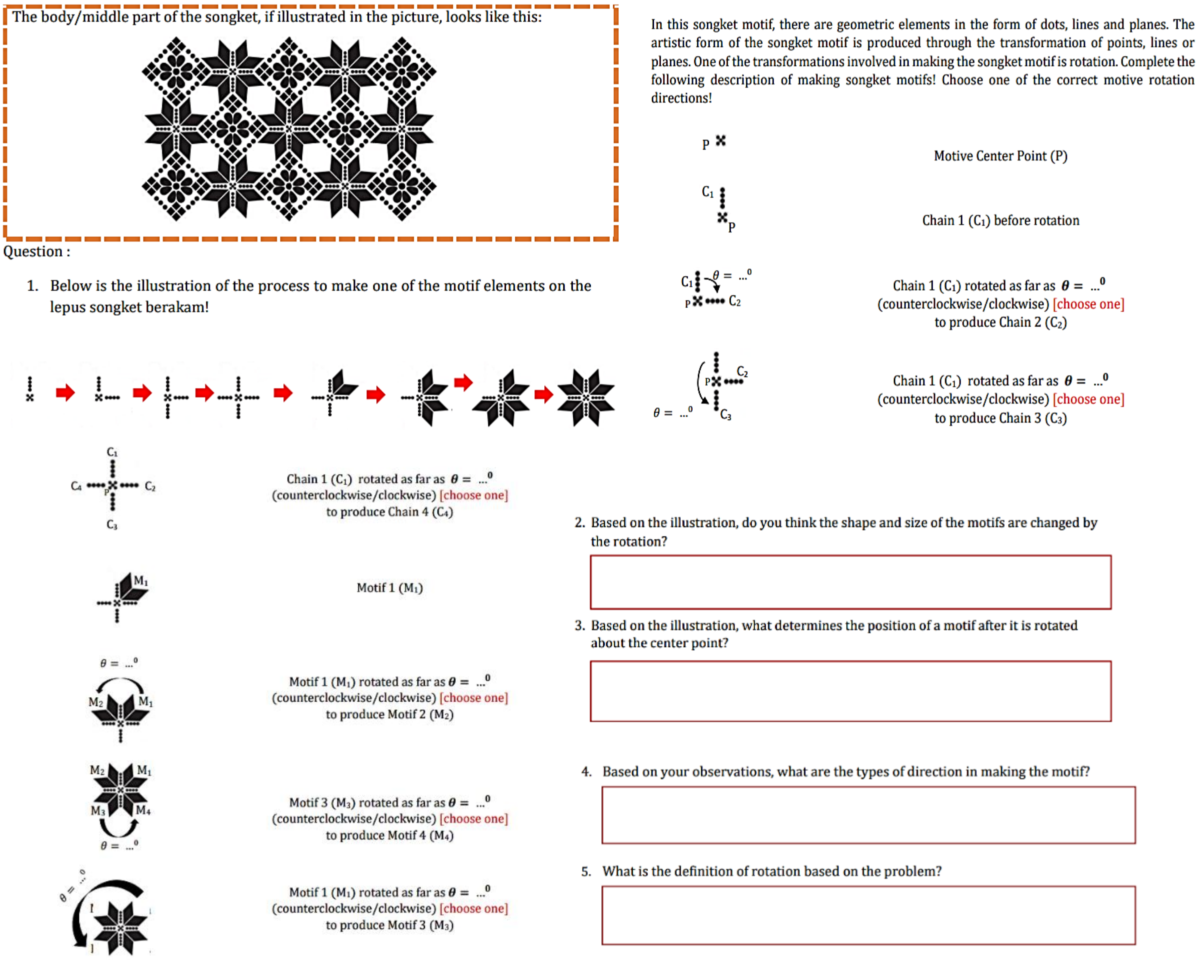


Figure 2. Questions in sharing task I

In Figure 2, question number 1 asks the students about how many rotation angles on the Palembang songket fabric motif were. Moreover, they are asked to determine whether the rotation is counterclockwise, with a positive rotation angle, or clockwise, with a negative rotation angle. Question number 2 asks the student whether the rotated object changes its shape and size. Question number 3 asks the students what determines the position of a motif. Question number 4 asks the students about the type of direction. The last question asks about the definition of rotation. One of the answers by the high ability student depicted on Figure 3.

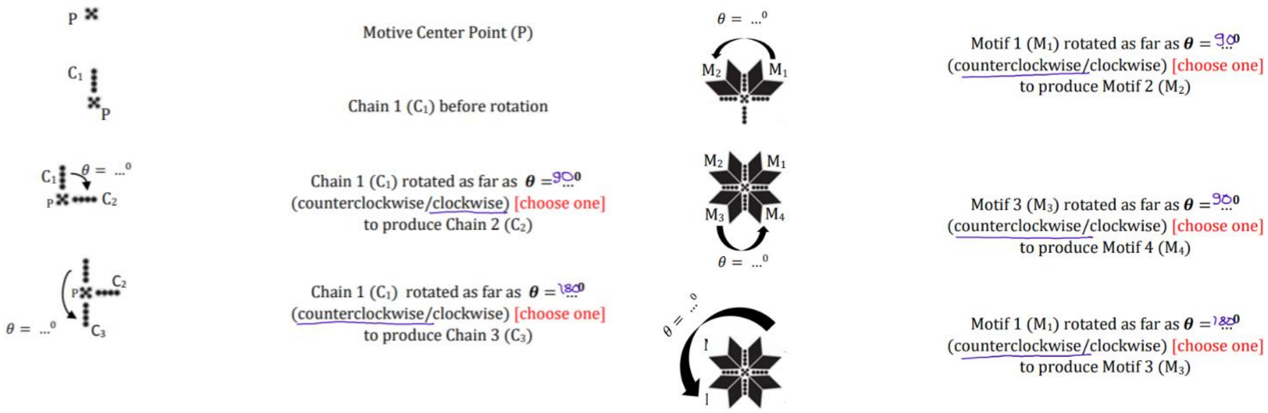


Figure 3. Student's solution to sharing task I

From Figure 3, the high ability student answers all sub numbers of questions correctly. Students answer correctly how big the angle and direction of rotation of the motif. Figure 3 illustrates that high students can correctly identify the similarities or differences in positions that are affected by the magnitude and direction of the angles on the shape before and after the results of the rotation. High students answer according to teacher predictions. While students with medium and low ability only answer three sub numbers of questions correctly. Errors in students' answers are found in the last 3 questions where students are wrong in determining how big the angle is. This illustrates that students are already able to correctly identify the similarities or differences in positions before and after the results of the rotation, but the solution contains a significant error. The students' answers were low according to the teacher's prediction, that is, students answered some of the questions correctly. Meanwhile, low students only answered one sub number correctly. Low students were not confident in answering questions, this is because there are lot of scribbles on the student activity sheet that they answer. This illustrates that low students have not been able to correctly identify the similarities/differences in the positions before and after the results of the rotation. This is in accordance with the teacher's prediction.

The teacher did not provide too much guidance during the sharing task. He was confident in the students' ability to understand the prepared student activity sheet. Then, the students were asked to discuss the answers in each group. The teacher presented the guide well. Some parts of the guide require the students to fill in their answers in the provided column. No students had difficulty in filling out the answer sheet because the guide to student activity sheet was complete. The teacher observed and occasionally answered questions of the students or group members during the conducive learning. Almost all group members were actively involved in finding answers on the student activity sheet.

During the learning activity that lasted for 60 minutes, the students completed sharing task to find the definition and characteristics of rotation using the context of the Palembang songket fabric motif.

After the sharing task, the teacher distributed the second student activity sheet, which contained the jumping task. The jumping task questions are described in Figure 4.

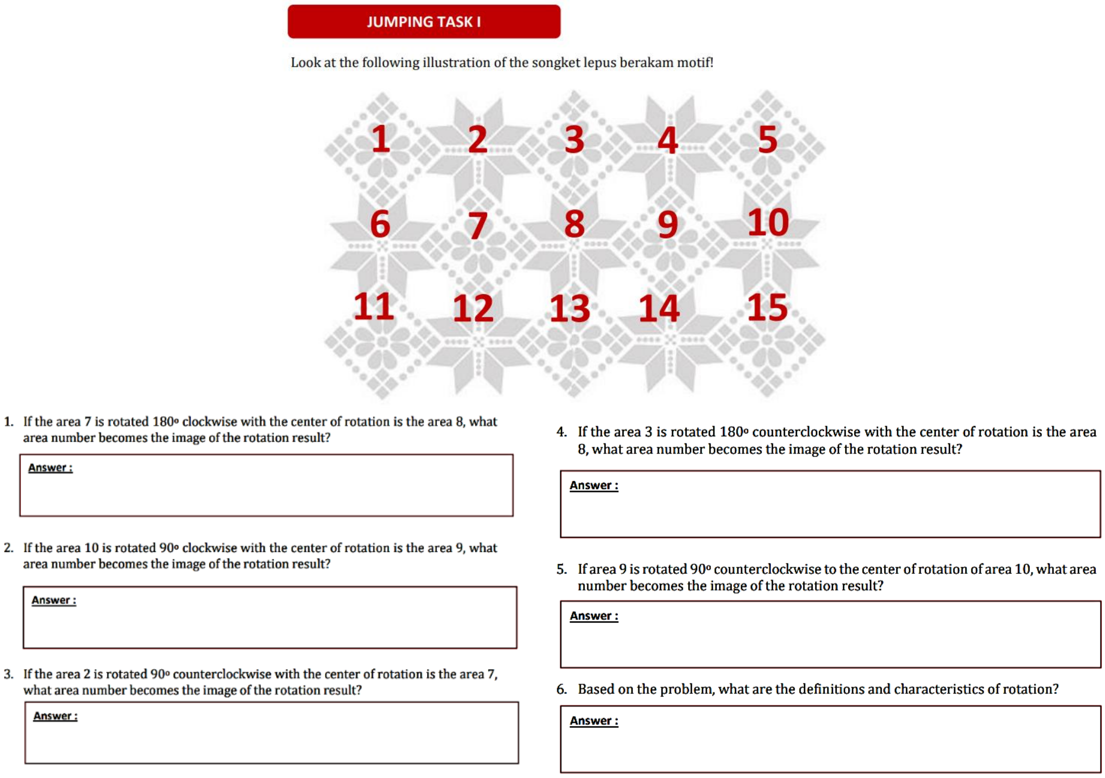


Figure 4. Questions in jumping task I

Figure 4 illustrates a series of questions in jumping task. Question numbers 1 to 5 ask students to determine the position of the rotated Palembang songket fabric motif. The last question asks about the definition and characteristics of rotation. One of the answers to the jumping task is presented in Figure 5.

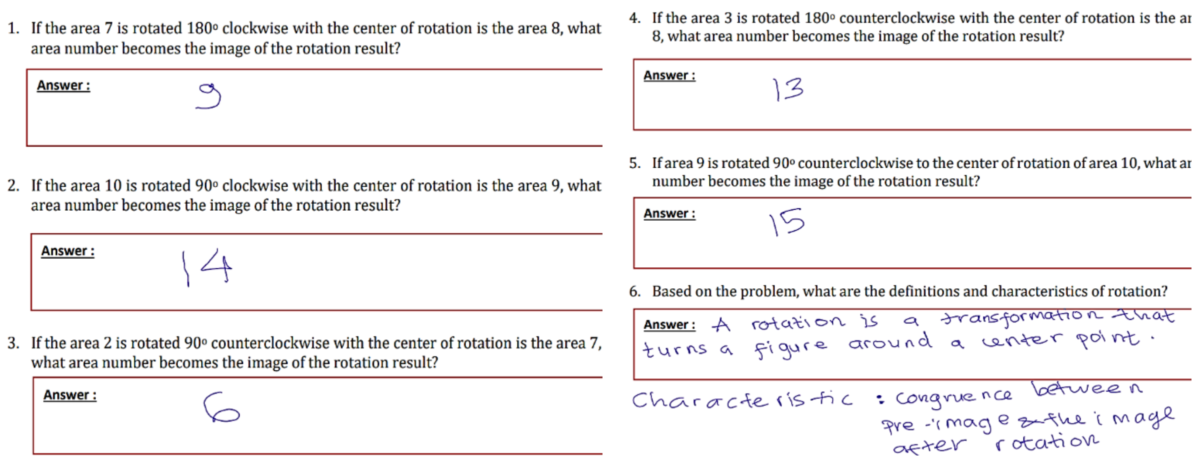


Figure 5. Student's solution to jumping task I

Figure 5 demonstrates that the low-ability student correctly answers all sub-number questions. The student can determine which area number becomes the image as a result of rotation. This indicates that students find it simple to learn the rotation using Palembang songket motif fabric. However, in response to the final question, the low student provided a correct but incomplete answer. There needs to be a direction, clockwise or counterclockwise, and an angle.

The students in group (a) and group (b) worked calmly on the jumping task questions. The teacher as a facilitator guided the discussion and provided opportunities for the groups to provide feedback and interact. At the end of the meeting, the teacher and the students concluded the learning outcomes. The teacher reminded the students to repeat lesson and asked them to learn the following materials: finding the relationship between two points before and after the rotation and concluding the rotation formula from the relationship between the two points.

After working on the jumping task, the teacher asked the representative of one group to come forward. One student from a group raised his hand; he wanted to present his answer. After the students had presented the questions on the jumping task, the teacher gave each individual question (evaluations), which were done individually for ten minutes. These questions aim to explore what extent the sharing and jumping activity could help students understand the concept of rotation. At the end of the lesson, the teacher concludes the learning process and asked the students to study the material at home at the next meeting as a preparation for the next morning.

Retrospective Analysis of Teaching Experiment at First Meeting

After conducting the teaching experiment, the researcher's next activity was a reflective activity with the model teacher and observers. The observers of this study were Nurjannah M.Pd., Anggita Coaline, S.Pd., Rizma, S.Pd., and the researcher. At the first reflection, Sir Dicky, as the mathematics teacher, told his experience while teaching in the student activity sheet. He said that the students who took part in the lesson were already active and enthusiastic. Moreover, many of them raised their hands before answering a question and worked effectively on sharing and jumping tasks. The program was continued with individual questions. It turned out that sitting crosswise in groups was very helpful for the learning. Furthermore, the model teacher conveyed his impressions and feelings at the end of the class. Anggita Coaline, observed the students with the initials MI, and reported that the students were very excited when the teacher asked them to come forward. Meanwhile, the researcher observed group (a) and reported that all members of actively participate in the class, and this group was the only group that had a little confusion on jumping task number one. However, the students finally did the task individually. After the researcher had delivered his opinion, another observer, Rizma, observed the group back corner. The group had mastered the material, so that they were more likely to work individually, and didn’t interact with friends. The last observer was Nurjannah, who noticed that a group of five people did not learn collaboratively but were busy with their own activity.

The Second Meeting: Determine the Shadow Coordinates of Rotated Objects

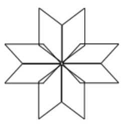
The learning began with the student's sitting position, that forms the letter "U" to enable the teacher to observe all the activities of the students. When the teacher was in front of the students, he greeted and check their attendance. The teacher asked about the students' readiness to take part in the lesson. As an apperception, the teacher asked the students whether they still remembered the previous lesson, namely the definition and properties of rotation. Next, the teacher conveys the material to be studied, namely the relationship between two points before and after the rotation. The teacher conveys the learning objectives and asks students to pay attention.

During the 'do' stage, students very enthusiastically learned the material. Only one or two students did not understand the experimental situation. At the beginning of the learning, the teacher asked some examples of rotation in real life with the following question.

Teacher	:	*Anyone can mention our previous lesson talk about?*
Student	:	*Definition and the characteristic of rotation*
Teacher	:	*That is right.*
Teacher	:	*So, what do you know about rotation and its characteristics? Anyone can answer it?*
Student	:	*I think, a rotation is a transformation that turns a figure around a center point. Then, I also noticed that it is congruence between pra-image and the image after rotation*
Teacher	:	*Good*

Learning mathematics with the PMRI approach allow the students to construct knowledge by interpreting the collected data around them in the form of tangible objects. During the core learning, the teacher distributed the sharing task, which consisted of six questions. He instructed them to read the work instructions first. Then, the students were allowed to ask their friends with the same culture as previous learning. Several questions in the sharing task in the second meeting is illustrated in Figure 6.

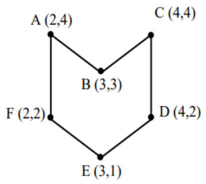
Try to observe the picture of the lepus songket with the latitude (star) motif. W can notice that the main motif of the songket is the image of 'latitude' or in Indonesian is known as a star.



The basic form of the latitude motif is as shown below:

Question :

1. Open the geogebra application (https://www.geogebra.org/classic). Make a illustration of the basic shape of the latitude motif in the GeoGebra application with t following conditions:



1. How does the shadow result from the basic shape of the latitude motif if it is rotated 90°, 180° and 270° clockwise?

Shadow Image			
Angle Rotation	90^0	180^0	270^0

2. Data the starting-point and end-point of the clockwise rotation results in following table!

Starting Point	Clockwise Rotation Endpoint		
	90^0	180^0	270^0
A (2,4)	A' (....,....)	A' (....,....)	A' (....,....)
B (3,3)	B' (....,....)	B' (....,....)	B' (....,....)
C (4,4)	C' (....,....)	C' (....,....)	C' (....,....)
D (4,2)	D' (....,....)	D' (....,....)	D' (....,....)
E (3,1)	E' (....,....)	E' (....,....)	E' (....,....)
F (2,2)	F' (....,....)	F' (....,....)	F' (....,....)
Notation (a,b)			

Figure 6. Questions in sharing task II

Figure 6 depicts a series of questions in sharing task. Question number 1 asks the students to draw the motif on GeoGebra. This activity allows students to explore the interactive learning process. Meanwhile, numbers 2 and 4 asked the students to draw the shadow of the motif rotation and determine the shadow coordinate of the rotated objects. Meanwhile, numbers 3 and 5 asked the students to draw a table with the clockwise and counterclockwise rotations of 90°, 180°, or 270°. Moreover, they should list the starting coordinate and the rotated coordinate to draw Palembang songket fabric motif. The last question asked the students about the notation used for rotations on the coordinate plane. This question aimed to observe the students' ability to conclude the relationship between the mathematical formula of rotation using a point-to-point O (0,0) with the mathematical formula of rotation angles of 90^o, 180^o, and 270^o in the Palembang songket fabric motif.

The teacher did not provide too much guidance during the sharing task. He only observed and occasionally answered questions of students or group members during the conducive learning activities. Almost all group members were actively involved in finding answers on the sheet as seen in Figure 7.

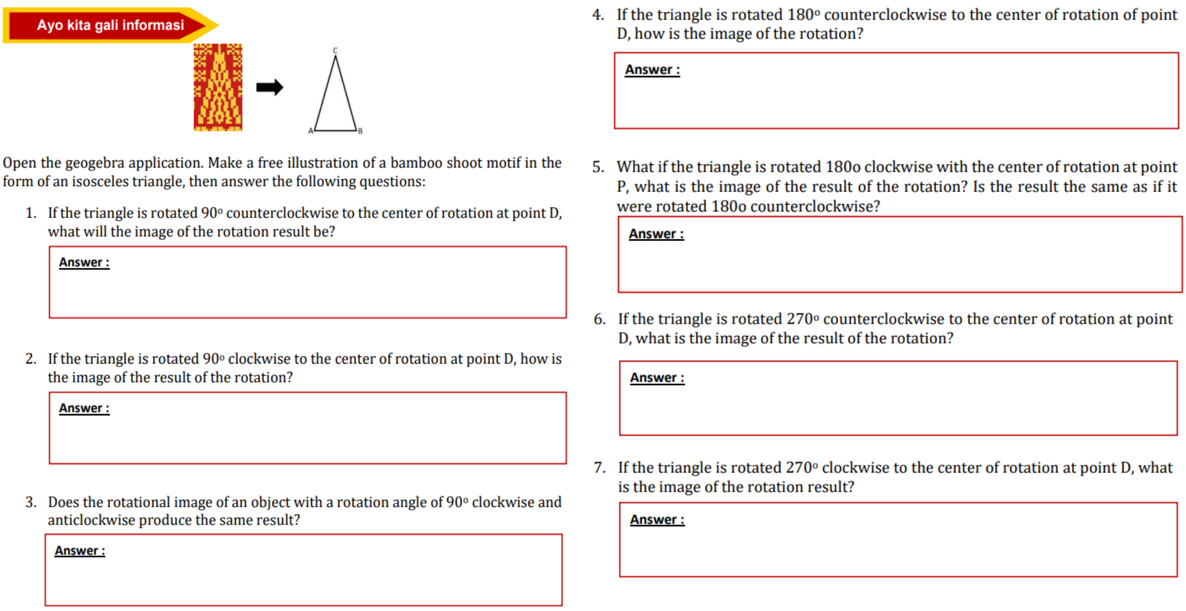
Figure 7. Collaborative learning in group

Students had completed an activity to collect data on the starting points and ending points before and after the rotation for 60 minutes. Unlike the first meeting, which does not use a laptop for the learning process, this meeting utilizes a laptop installed with GeoGebra application to help students visualize more complex shapes before and after rotation as seen in Figure 7. The plan stages of second meeting were prepared based on the input of the teaching and observer teams and the results of the reflection of first meeting. The two stages are still the same, because they employed collaborative learning with the PMRI approach. The prepared design required the students to be divided into three groups.

During the second meeting, the teacher did not give too much guidance on GeoGebra because everything was listed on the sheet. He was confident in the students' ability to understand the prepared activity sheet. Students were asked to discuss the answers in each group. Then, the teacher presented the guide well. Even in some parts of the guide, the students just needed to fill in their answers in the provided column. Of the three groups that working on the sheet, only one group had difficulty operating Geogebra because their laptops did not support the application. Students in the other two groups had no difficulty in filling out the sheet because the student activity sheet guide was complete.

The teacher only observed the students and occasionally answered questions of the students or group members during the conducive learning activities. Almost all group members were actively involved in finding answers on the sheet. During the learning activity, which lasted for 60 minutes, the students completed the activity related to find the rotation formula through the relationship between the starting point and the endpoint of rotation using the context of the Palembang songket fabric motif. Furthermore, only group A presented the experimental results to discuss in the student activity sheet due to limited time. The teacher served as a moderator who guided and directed the discussion to achieve the learning objectives. After about 30 minutes, the teacher tried to guide the discussion, but he still dominated the communication. However, the students did not seem enthusiastic about this discussion activity.

After the sharing task, the teacher distributes the jumping task completed by students in all groups. Moreover, he asked the students to pay attention to the questions in jumping task. The jumping task question hard level is above the sharing task level. First, the students were asked to use geometry software or an online tool to explore rotations, such as GeoGebra. Then the students were asked to draw a triangle and label of vertices. Moreover, they were asked to draw a point P and mark it as a center. Some students had difficulty identifying the direction of the rotation. The teacher suggested that they visualized P as the center of a clock, with the minute hand pointing to a vertex on the preimage. Then, the following questions asked the students to draw the image of the triangle after the given rotation. They should analyse pictures of pre-images and images and discuss what rule of rotation had the same result. Some students would probably rotate a figure around its center or its vertices, not around point P. Thus, the teacher should reread the instructions together with the students. He asked the students to explain the differences between rotating a figure around an exterior point, a point on the figure, and an interior point. Several questions in the jumping task questions are presented in Figure 8.


Ayo kita gali informasi

Open the geogebra application. Make a free illustration of a bamboo shoot motif in the form of an isosceles triangle, then answer the following questions:

1. If the triangle is rotated 90° counterclockwise to the center of rotation at point D, what will the image of the rotation result be?

   Answer :

2. If the triangle is rotated 90° clockwise to the center of rotation at point D, how is the image of the result of the rotation?

   Answer :

3. Does the rotational image of an object with a rotation angle of 90° clockwise and anticlockwise produce the same result?

   Answer :

4. If the triangle is rotated 180° counterclockwise to the center of rotation of point D, how is the image of the rotation?

   Answer :

5. What if the triangle is rotated 180o clockwise with the center of rotation at point P, what is the image of the result of the rotation? Is the result the same as if it were rotated 180o counterclockwise?

   Answer :

6. If the triangle is rotated 270° counterclockwise to the center of rotation at point D, what is the image of the result of the rotation?

   Answer :

7. If the triangle is rotated 270° clockwise to the center of rotation at point D, what is the image of the rotation result?

   Answer :

Figure 8. Questions in jumping tasks 2

Figure 8 illustrates a series of questions in jumping task. Question number 1 to 7 ask students to draw the image of the rotation with variety of angles. Students will practice considering all the aspects of a rotation: center, angle, and direction of rotation. Students also give an opportunity to choose appropriate tools strategically like Geogebra.

The teacher encourages and support opportunities for peer interactions. When students worked on jumping task questions, students in group (a) and (b) were working calmly. During the observations, group (b) demonstrates collaborative learning.

Figure 9. Ask for help culture in collaborative learning

Figure 9 shows that the male student (low ability) asked for assistance with his teammate (high ability) because he did not understand what the problem is about. His friend helped him understand the concept until he could answer the question. At the same time, the other two students enjoyed working on their activity sheets. After asking his friends, the target student tried to solve the problem in his way until he nodded and smiled. The following are the conversations and expressions of the target students when asking and working on the question.

Student A	:	*Could you please help me to find this answer?*
Student B	:	*Yes, of course. First, let us get up before the rotation, if we rotate it 90 degrees, then the result will be great. Did you understand it?*
Student A	:	*Oh yeah, thank you*

After students had completed the jumping task, they presented the results of their answers. The teacher, as a facilitator, guided the discussion and allowed other groups to give feedback and interact with each other. At the end of the meeting, the teacher and students concluded today's learning. Then the teacher asked the students to review today's lesson and study the following material at home to find the relationship between two points before and after the rotation and make a rotation formula from the relationship between the two points.

Retrospective Analysis of Teaching Experiment at Second Meeting

After conducting the teaching experiment, the researcher's next activity was a reflective activity with the model teacher and observer. Anggita Coaline observed the students with the initials RV and reported that the student showed enjoyment of the learning and interacted with their friends effectively. Furthermore, the researcher observed the group of students and has revealed that they actively participated in the class. Moreover, this group was the only group that had a little confusion about the jumping task. Meanwhile, another observer, namely Rizma, observed the group in the back corner and has reported that the group had mastered the material. Consequently, they were more likely to work individually, and did not interact with their friends. The last observer, Mrs. Nurjannah, has revealed the researcher should have ensured the school conditions allowed the research to show the video during the apperception. In addition, the video should be displayed in a short time to motivate and stimulate students' curiosity so that the learning time will be more efficient. Moreover, the teacher should inspire the students to be more actively involved in discussions. In fact, a small number of students were not actively involved and demanded the teacher's attention to invite them to be involved in the learning process more effectively.

In general, this study showed that the use of the PMRI approach to the context of Palembang songket motif fabric had an important role in supporting the learning process of rotation. The context of Palembang songket motif fabric became the starting point in helping students understand basic concepts in rotation (Sari & Putri, 2021). The problems associated with the activity made Palembang songket fabric motif attractive to students, so that they participated in a series of activities designed with enthusiasm. It was because students have seen and heard about Palembang songket fabric motif and became a realistic context for them (Putri & Zulkardi, 2017).

The problem formulation was a description of the learning trajectory of students in learning rotation using the PMRI approach from the informal to the formal stages (Sembiring et al., 2008). Gravemeijer and Cobb (2006) mentioned four levels in developing the model, namely the situational level, referential level, general level, and formal level. Descriptions were carried out starting from the development of students' abilities from Palembang songket fabric motif formation to the formal stage of finding and determining the rule of rotation.

At this situational level, there were two learning trajectories. First, the students must choose the angle and the direction of an illustration of the process to make one of the motif elements on the Palembang songket fabric. Second, the students must write how big the angle of one chain is to produce another chain and must choose whether the direction is counterclockwise or clockwise. To complete the activity at this situational level, students must master the concepts of rotation, angle rotation, and types of direction in rotation (Thaqi & Gimenez, 2011).

Learning trajectories obtained at this referential level were obtained by using models found by students at the situational level (Putri & Zulkardi, 2019). Students had to decide which area of the

Palembang songket fabric motif became the image of a rotation using an angle. This showed the achievement of students in developing their strategies to form a rotation formula. The ability of students to determine the rotation formula showed their ability to change the context in a formal direction (Wijaya, 2012).

Whereas in the general stage, the students found the difference between rotation in any direction and angle. At the formal level, the learning trajectory obtained was to change the model from the previous level into mathematical symbols that led to the concept of rotation (Bansilal & Naidoo, 2011). At this stage, students were able to find a mathematical model for the rotation formula after knowing the relationship between the starting point and the end point of the Palembang songket fabric motif production.

CONCLUSION

This study concludes that utilizing Palembang songket fabric motif has an essential role in generating student learning trajectories in rotational learning. This can be seen from the attitude of students who pay attention and are enthusiastic in following the learning activities carried out. The resulting learning trajectory contains PMRI characteristics, where rotational learning is designed from the informal to the formal stage which can be seen in emergent modelling. This approach has helped students discover and understand the concept of rotation and improve their reasoning ability through activities, such as understanding the definition and nature of rotation, determining the image of a rotated object, finding the mathematical relationship between the starting point and endpoint of the shape before and after the rotation. A series of activities has enabled the students to perform an experience-based activity to increase their understanding of rotation. Furthermore, collaborative learning can positively affect students because they can build a sense of care for their friends. The LSLC system enables teachers to build a sense of responsibility, give opinions and input to other teachers, and work well with fellow teachers and students.

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