OPTIMIZATION OF VISUAL-SPATIAL ABILITIES FOR PRIMARY SCHOOL TEACHERS THROUGH INDONESIAN REALISTIC MATHEMATICS EDUCATION WORKSHOP

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Abstrak
Kemampuan visual-spasial sangatlah dibutuhkan dalam memahami berbagai bentuk-bentuk geometri dalam kehidupan sehari-hari. Oleh karena itu guru perlu memahami dan memiliki kompetensi yang baik terkait kemampuan visual spasial. Artikel ini difokuskan pada hasil pelaksanaan workshop PMRI pada materi bangun datar bagi guru-guru KKG Gugus 1 Kec. Bilalang Kota Kotamobagu. Metode pengabdian yang digunakan terdiri dari beberapa tahapan, namun pada atikel ini difokoskan pada tahapan mengembangan dengan metode desian riset yaitu tahap preliminary design, tahap eaching experiment, dan tahap retrospective analysis. Dari hasil workshop tersebut terlihat bahwa guru-guru peserta workshop telah mampu memahami konsep dasar bangun datar menggunakan kemampuan visual-spasial. Selain itu, peserta juga mampu menunjukkan ketertarikan dalam penggunakan pendekatan PMRI pada pembelajaran. Di akhir workshop peserta juga telah menghasilkan bahan ajar bangun datar untuk di implementasikan pada pembelajaran matematika di kelas.
Kata kunci: Visual-spasial, Workshop PMRI, Program Kemitraan Masyarakat

Abstract
Visual-spatial abilities are needed to understand various geometric shapes in everyday life. Therefore, teachers need to understand and be competent in visual-spatial abilities. This article focuses on the results of the PMRI workshop on flat building materials for teachers of KKG Gugus 1 Kec. Bilalang Kotamobagu City. The service method consists of several stages, but in this article, the focus is on the development stage with the research design method, namely the preliminary design stage, teaching experiment stage, and the retrospective analysis stage. From the workshop results, the teachers participating in the workshop could understand the basic concepts of flat shapes using visual-spatial abilities. Apart from that, participants were also able to show interest in using the PMRI approach to learning. At the end of the workshop, participants also produced teaching materials for flat shapes to be implemented in mathematics learning in the classroom.
Keywords: Visual-spatial, PMRI Workshop, Community Partnership Program

INTRODUCTION

The shape material in elementary school is enjoyable. This is because students already have the basic concept of geometric shapes informally. Shape material is more likely to be understood by students than other mathematics material in elementary schools (Sholihah & Mahmudi, 2015; Murfuah et al., 2016; Hidajat et al., 2019). This is because students have been familiar with the concept of geometric shapes such as flat shapes since they have not yet entered school, such as lines, planes and objects in the form of flat shapes (Royani & Saufi, 2016; Rahimah, 2017; Hasanah, 2021). However, research shows that elementary school student's mastery of the flat shape concept still needs to improve (Astutik, 2017; Agustina et al., 2019; Melisari et al., 2020).

Not only that, the ability of elementary school teachers in flat material is very worrying. Based on the results of Sarjiman's research (Kamarullah, 2019), 59.42% of elementary school teachers make conceptual errors in geometry material, exceptionally flat shapes. This causes students to need to understand the concept of flat shapes (Adriani et al., 2017; Sopiany & Rahayu, 2019; Fauzi & Arisetyawan, 2020). Nur'aeni (Putri, 2020) stated that almost 95% of fifth-grade elementary school students said quadrilaterals were only rectangles and squares. Apart from that, Sunardi (Khoiri, 2014) said that many students still say that a rhombus is not a parallelogram.

One effort to overcome the problems above is to conduct training/workshops for teachers to improve the quality of learning and mathematical concepts in plain material. Workshops using PMRI are considered the right solution to overcome the problems above. The results of Ratu Ilma's research (2009) regarding the potential effects of PMRI training on mathematics teachers in Palembang show that 100% of the training programs implemented are relevant/suitable to teacher needs, 100% of the material presented also following the needs in carrying out teacher duties at school, and 100% of the training participants were delighted with the training provided and required continuation of the PMRI training. This success is also inseparable from PMRI's approach, which focuses on context to make learning more meaningful (Istikhomah, 2018; Dwirahayu et al., 2020).

PMRI may be a promising approach to learning mathematics. Various literature states that RME/PMRI can improve students' mathematical understanding. The Netherlands, as a pioneer of RME, has successfully implemented this. In the United States, several schools have begun to use RME curriculum materials developed in collaboration between the University of Wisconsin and the Freudenthal Institute through a project called MiC (Mathematics in Context) (Arista et al., 2018). Also, countries such as South Africa, Portugal, England, Spain, Brazil, Denmark, Japan, Malaysia, and Singapore have implemented RME in their school curriculum.

In this article, we will explain the implementation of a flat building learning workshop using the PMRI approach in elementary schools, starting from design to implementation and retrospective analysis of the workshop results. The final result of this workshop is expected to be an increase in visual-spatial abilities for elementary school teachers in Bilalang District, Kotamobagu City.

METHOD

The solution methods provided to answer partners' problems in this service are implemented using several methods. This article's discussion is limited to the research design stages, namely preliminary design, teaching experiment, and retrospective analysis. The implementation of this stage will be carried out from August to October 2022, with the subjects of service being teachers who are members of the KKG Cluster 1, Bilalang District, Kotamobagu City, North Sulawesi Province. Data collection techniques use observation, tests, and interviews with a qualitative approach, namely data collection, data reduction, and conclusion. The analysis used is observation analysis, test analysis, and interview analysis.

RESULT AND DISCUSSION

Preliminary Design

In the initial stage before the workshop began, PMRI-based flat building learning was designed. The context used in this lesson is the context of the traditional game "Cengek" and other contextual problems such as rice fields and other objects that are flat shapes. This learning is carried out with several activities that can lead students/workshop participants to understand the existing concepts of flat shapes, especially the properties and relationships between quadrilaterals.

The learning material that will be implemented in this workshop is focused on identifying rectangular flat shapes. Problems with rectangular shapes usually start from errors in understanding the rules or definitions. For example, a parallelogram is a quadrilateral with 2 pairs of parallel sides. From this definition, many people think there is only one type of parallelogram, even though a quadrilateral with 2 pairs of parallel sides is not just a parallelogram. This happens because, in conventional mathematics learning, there is a lack of understanding of existing rules/definitions.

Based on the properties of flat shapes, the various types of quadrilaterals and their relationship to each other can be depicted with the following scheme:

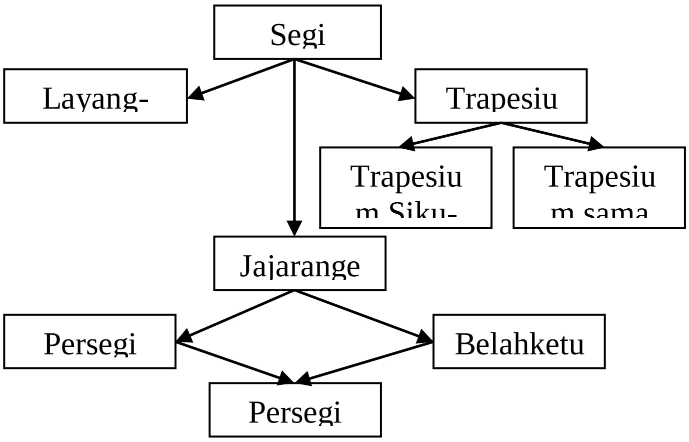

Figure 1. Relationship between flat shapes based on their properties

Based on the scheme above, various learning activities were designed to instill these flat-building concepts. The activities implemented here are designed based on the hypothesized learning trajectories and thinking processes of students/workshop participants. This will fulfill the principles and characteristics of PMRI and will help workshop participants implement this learning in the classroom learning process.

The following is a learning trajectory in learning flat shapes that has been designed:

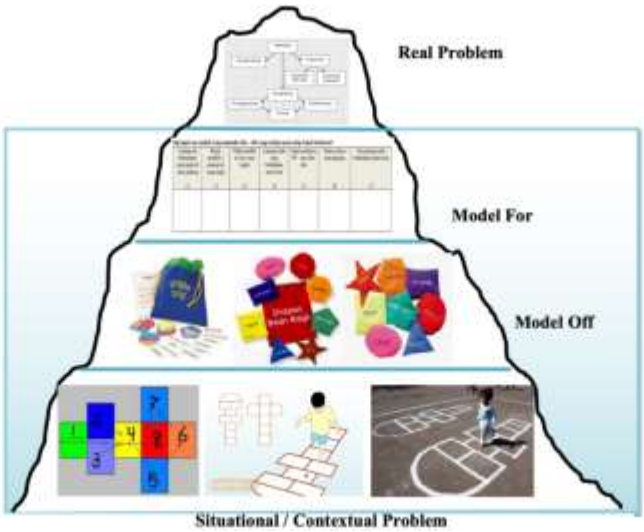

Figure 2. Designed Flat Building Learning Cross

The explanation of activities in learning flat shapes listed above using the PMRI approach is explained as follows:

Activity 1: Draw a checkerboard and determine whether the picture has simple, flat shapes.

a. Form of Activity

Students are reminded again about the Cengek game. Then, students are asked to describe the forms of Cengek they know.

b. Activity Goals

Students can identify what flat shapes are in the Cengek drawings they make.

c. Activity Description

In this activity, at the beginning, the teacher will ask about what games students often play and whether students like playing them. Then, the teacher asks whether the students know the game Cengek. Alternatively, if students have mentioned the Cengek game, the teacher can explore the various types of Cengek that the students already know. Then, students are asked to describe it and determine whether there are simple flat shapes in the Cengek picture based on the elements of flat shapes they have studied in class II. In addition, students are asked to determine which flat shapes in Cengek are quadrilaterals.

d. Student Thinking Conjecture
   1. Students already know and have played Cengek
   2. Students draw various forms of Cengek based on students' daily experiences
   3. Students can draw Cengek in the form of a rectangle, triangle, or circle
   4. Students may realize that there are various forms of simple flat shapes in Cengek

Activity II: Filled Bag

a. Form of Activity
   Students will identify various rectangular shapes from a bag containing several flat shapes. This activity is a continuation of the previous activity to see the extent of students' understanding of the definition of a rectangular shape and its types. This activity does not use student activity sheets. The teacher only conducts questions and answers classically and in groups.
b. Activity Goals
   Students can group which flat shapes are quadrilaterals and which are not.
c. Activity Description
   Each group gets 1 bag containing various flat shapes, both rectangular and non-quadrilateral. Students are asked to group which flat shapes are quadrilaterals and which are not. In this activity, the teacher also asks several questions to determine why students say that a geometric shape is a quadrilateral and not a quadrilateral.
d. Student Thinking Conjecture
   1. Students may need to correct their grouping of flat shapes in the bag, such as only removing a square or rectangle to show that the shape is a quadrilateral.
   2. Students can group triangles into quadrilaterals because they are similar in that they have straight sides.
   3. Students can group correctly and find out what flat shapes are quadrilaterals and which are not.

Activity III: Properties of quadrilaterals

a. Forms of Activity
   Students will check various types of rectangles given in LAS using a Pipette, Protractor, or Ruler. Here, students will check how many pairs of parallel sides, how many pairs of equal angles, etc., are rectangular in LAS.
b. Objective
   Through this activity, students will know the similarities and differences in properties between rectangular shapes. Not only that, students are expected to not only be able to list the properties of a quadrilateral but also be able to relate these properties to the properties of other shapes. Students will realize that the characteristics of flat shape A are also present in flat shapes B and C and vice versa. In short, this activity is expected to support students' understanding of the relationship between flat shapes.
c. Activity Description
   Students discuss in groups and work on questions on LAS. Students are given the freedom to apply various strategies to check the suitability of the properties of the given plane figures. Students can compare them by drawing lines using a ruler, measuring angles using a protractor, and using pipettes provided by the teacher to see the parallelism of the sides of the given flat shape.
d. Student Thinking Conjecture
   Students can use tools such as rulers and bows to determine the similarities and properties of each rectangular shape
   Students can mention new properties not found in LAS, such as diagonals or symmetry.
   Students may need to be corrected in determining which side is opposite, which is adjacent, which angle is opposite, and which is adjacent.
e. Class Discussion
   Class discussions were held to explore further participants' answers written on the worksheet. Discussions were also held regarding bullets.

Activity IV: Relationship between Quadrilateral Properties: Parallelogram, Square, Rectangle, Rhombus

a. Form of Activity

Students draw a particular quadrilateral and check the relationship of the quadrilateral to other quadrilaterals.

b. Objective

Students know the relationships between quadrilaterals, for example, squares, rectangles, rhombuses, and parallelograms.

c. Activity Description

Students discuss and work on LAS in their respective groups. Several groups will present the results of their discussions in front of the class. During class discussions, students can convey reasons, share information, or clarify their understanding. The teacher can confirm some of the students' answers during the discussion.

d. Student Thinking Conjecture

1. Students can explain well that a rhombus is a parallelogram because it has the same properties, namely 2 pairs of parallel sides.
2. Students can state that a rhombus is a parallelogram whose sides are the same length.
3. Students may be unable to answer this question because they need to understand the relationship between the properties of quadrilaterals.
4. Students can see the relationship between parallelogram properties.
5. Students may experience difficulties because they only pay attention to the visual form of a shape without considering the similarities in properties between quadrilaterals.

e. Class Discussion

In the discussion at this final stage, it is hoped that students will be able to convey their strategies and ideas in solving the problem given, namely about the relationship between the properties of quadrilaterals. So they will better understand the existing problems. Here, the presenter's task is only to facilitate discussion and guide participants toward understanding the concept of rectangular shapes regarding the problems contained in LAS.

Teaching Experiment

The learning design was implemented in a mathematics learning workshop using the PMRI approach at SD Negeri 1 Kotamobagu. Before starting the learning activity, the speaker gave an icebreaker to the participants to increase their enthusiasm and to attract the participants' attention to follow the material that would be given.

Participants are conditioned to sit in groups of 2 people/groups to support discussion. Then the presenter gave several questions that led the participants to enter into the material that would be presented, such as "Has anyone ever played traditional games?", "Can you please tell me the game's name?", Does anyone know the game Cengek?". Then, the presenter showed a video about the Cengek game so that participants could remember the game and become a stratifying point in the learning that would be carried out.

Then, the presenter asked the participants about their experiences in the Cengek game, whether they had ever played it, and whether there were geometric shapes. Next, participants draw shapes of Cengek that they know and often use in games, as shown in Figure 3. Participants are invited to complete it in groups, and each group may be able to draw more than 1 model of Cengek in LAS 1. Here, the presenter acts as a facilitator during the learning process. to guide participants to solve the problems in LAS 1 given so that they are following the expected objectives.

Figure 3. Participants draw Cengek based on their experiences

In this case, the presenter guides the participants to connect the elements that form a flat shape with the name of the flat shape based on the Cengek drawn by the participant. By asking several questions such as "What is the name of a shape/shape that has 3 corners and 3 sides?", "What about a flat shape with 4 sides, 5 sides? What is the flat shape called?" This is done to make participants aware that the name of a shape (polygon) depends on the number of angles and sides.

After participants understand the names of flat shapes based on sides and angles, the presenter will move on to the next activity in this lesson. The speaker gives 1 bag (Bag Shapes), which contains flat rectangular and non-rectangular shapes. Participants work in groups, classifying rectangular and non-rectangular shapes as in Figure 4.

Figure 4. Participants group rectangular and non-quadrilateral shapes

Then, the presenter instructed that participants had to take out rectangular shapes from the bag in this activity while non-rectangular ones were put back in the bag. Here, participants work according to the instructions. It is hoped that participants will be able to take these shapes by considering the definition of a rectangle or each shape's typical characteristics. After grouping, participants work on LAS 2 to determine the properties of the quadrilaterals they have grouped (Figure 5).

Participants here are free to use various strategies to identify the properties of the quadrilaterals given in the worksheet. Participants can compare the angles by measuring them using a protractor or see the parallelism of each side, etc. The results of their observations were put into a table containing the properties of existing quadrilaterals so that participants indirectly knew the properties of flat shapes from the activities they carried out.

Figure 5. Participants identify the properties of quadrilaterals and match them with the quadrilateral images in the LAS.

Next, the presenter asked several participants to present the results of their work in front of the class, explaining their strategy in grouping. Meanwhile, the other group pays attention while asking if some different answers or statements need to be clarified, as in Figure 5. When participants use different strategies to present their answers, the presenter asks several questions to gain in-depth knowledge (insight) from the participants about the answers given. Written on the answer sheet. The presenter can explore participants' understanding by asking questions; "Who can name the types, properties, and relationships between quadrilaterals?". Next, participants confirm the types of quadrilaterals and the properties of quadrilaterals.

Based on this activity, the presenter asked the participants several classical questions to confirm the concept of the activity they had carried out, such as “What quadrilateral has the property that all sides are the same length? (Rhombus and square)", "Then what is the main difference between a rhombus and a square?", "What quadrilaterals have the property of having 2 pairs of parallel opposite sides? (Parallelogram, rectangle, rhombus, and square)". Then, the speaker emphasized that it turns out that the quadrilaterals are related to each other because they have the same properties.

Before carrying out the next activity, the speaker asked the following contextual questions: Mr. Lutfi has a rectangular rice field with parallel sides. What shape does Pak Lutfi's land look like? Is it a parallelogram?

This question is asked to direct the participants to the activity. If no participant can answer, the teacher invites the students to work in groups for the next activity. First, the speaker writes the meaning of a parallelogram on the board. A parallelogram is a quadrilateral that has 2 pairs of parallel opposite sides. Next, the speaker explained that the requirement for making a parallelogram is only to have 2 pairs of parallel opposite sides. Not required, long or short. This means that the sides can be a mix of short and long, and they can also be all the same short/long.

The speaker asks 1 participant to come forward in front of the class to practice drawing the shape of Mr. Lutfi's rice field using a pipette/straw by giving the following explanation: If the parallel sides of the parallelogram were these 2 pairs of pipettes/straws that are being held, try to make parallelogram (the presenter asks the participants to make a parallelogram while considering the meaning of parallelogram that has been written).

Here, participants demonstrate how to make a parallelogram from the 2 pairs of pipettes provided and draw the shape on the whiteboard. The speaker asked, "Apart from a roughly rectangular parallelogram, what else can you make from 2 pairs of parallel pipettes?" Here, it is hoped that participants can make another quadrilateral, namely a rectangle. If the participants can make a rectangle, the presenter explains to the participants the changes that occur from a parallelogram to a rectangle. From the same 2 pairs of parallel sides, not only can parallelograms be made, but they can also be rectangles.

From here, the presenter asked the participants again that if Mr. Lutfi's rice field had 2 parallel sides, then Mr. Lutfi's rice field could be in the shape of a parallelogram, rhombus, square, and rectangle. The speaker invited participants to work on LAS 3, working in groups. Things that need to be discussed: Initially, it was a parallelogram, but now it can turn into a rectangle. In your opinion, "What characteristics differentiate a parallelogram and a rectangle?" or "What property does a rectangle have but does not have a parallelogram?" (Right angle). The presenter develops the participants' understanding so they can understand that there are many parallelograms, one of which is a parallelogram with right angles and is called a rectangle. Because it has new properties, it is given a name different from the first parallelogram.

At the conclusion stage, the presenter asked participants to provide conclusions from the learning process through the activities that had been carried out. However, before that, the speaker emphasized the concept of a quadrilateral, namely a parallelogram, that there are 3 other unique shapes: a rectangle, a rhombus, and a square. A parallelogram's properties are found in rectangles, rhombuses, and squares. Conclusions obtained from this learning include:

1. A rectangle is a parallelogram with right angles. (All the properties of a parallelogram are present in a rectangle, and because there are new properties in a rectangle, it is given a different name from a parallelogram.)
2. A rhombus is an equilateral parallelogram.
3. A square is a parallelogram with equal sides and right angles. A square can also be called a rhombus, whose angles are right angles, or a rectangle, whose sides are the same length. So, the one that has the most different properties is the square.

After the discussion, the presenter provided an evaluation as the closing of this activity, and then together, the participants reflected on the advantages and disadvantages of each activity they had completed throughout the day.

Retrospective Analysis

The main problem in this learning is how to instill the concept of relationships between the properties of rectangular shapes. From the ongoing learning process, various exciting findings were obtained, including.

In activity 1, participants did not understand the meaning of a quadrilateral; some said that a square is a quadrilateral, but a rectangle is not a quadrilateral. After further clarification, it turned out that what the participants knew was that a square was called a quadrilateral. Therefore, the speaker reminded and emphasized the definition of a quadrilateral: a flat shape with 4 sides and 4 corners.

Apart from that, there was an error in the use of terms from one of the participants, namely that he used the term "quadrilateral" and not quadrilateral.

In activity 2, namely classifying rectangular and non-rectangular shapes, an interesting thing happened when a participant classified one of the non-quadrangular shapes whose sides were not straight as a quadrilateral (Figure 6). After investigating, it turned out that the participants needed to understand that each quadrilateral side must be straight. Nothing should be straight. It is fascinating that there is also a mistake about flat figures among elementary school teachers.

Figure 6. Participants classify non-quadrangular shapes into quadrilateral shapes

In activity 3, participants can generally determine the properties of a quadrilateral based on the properties table provided. However, participants still had difficulty comparing the existing properties with the rectangular shape. Participants still need clarification about which side is opposite and which is adjacent. As a result, participants still needed clarification about whether the quadrilateral's two opposite sides were parallel. However, after being given guiding questions, participants could finally determine which sides were parallel and which were not.

In activity 4, there are no significant obstacles to this activity. This is because participants already understand the properties of quadrilaterals based on activity 3 that they have carried out. To emphasize the concepts studied, the presenter confirms that squares, rectangles, and rhombuses are unique shapes of parallelograms.

CONCLUSION

Based on the activities carried out above, it can be concluded as follows:

1. Mathematics Learning Workshop using the PMRI approach can improve the visual-spatial abilities of elementary school teachers as workshop participants on shape material
2. Mathematics Learning Workshop using the PMRI approach can broaden teachers' insight into learning flat shapes in elementary schools. Suggestions from the results of this workshop are:
3. Elementary school teachers may be able to use the PMRI learning design obtained in this workshop when teaching material about flat figures.
4. It is hoped that the PMRI learning design in this workshop can be developed on other materials.

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