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Learning Innovation of Quadrilaterals with The Context of Burongko Bugis Cake in Improving Critical Thinking Ability

Abstract

One goal of learning mathematics is to foster students' critical thinking skills, but in reality, this has not been realized well in Indonesia. This study aims to produce a learning trajectory that can help students grow their critical thinking skills in studying quadrilaterals using the Burongko cake context and to describe the profile of students' critical thinking skills after the learning process. This study uses a design research method which comprises three stages, namely preliminary design, experimental design, and retrospective analysis. This research was conducted at MT's As'Adiyyah Bontouse with 22 students of class VIII B. The results showed that the design of the learning trajectory of rectangular shapes with the context of the Burongko cake can improve students' understanding in learning quadrilaterals with ease and fun. This is because, in the learning process, mathematical concepts are associated with students' daily habits. So that they are enthusiastic, active in the learning process, and critical in responding to the problems given. In addition, the resulting learning trajectory has relevance to indicators of critical thinking skills, which include interpretation, analysis, evaluation, and decision making. From the results of the interview, it was found that there was no significant difference in critical thinking skills between students who had high and low knowledge. However, subjects with high mathematical abilities could carry out critical thinking processes to solve problems much better than subjects with low mathematical abilities. The results provide information about the use of local Bugis culture as a context of learning mathematics to improve students' critical thinking skills.

Keywords: critical thinking skills; design research; learning trajectory; traditional Bugis cakes

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Introduction

The basic skills that students need in the 21st century are critical thinking, communication skills, collaboration skills, and creativity (Aktaş & Ünlü, 2013). If students have critical thinking skills, they will try to find the truth by thinking systematically, interpreting problems, analyzing problems well, and solving problems using appropriate methods (Anderson, T., Garrison, D.R., dan Archer, 2004). Thus, critical thinking is one of the basic skills that must be grown in students to become successful people in the 21st century.

Various efforts have been made by the government to foster students' critical thinking skills through formal educational institutions. As written in the rationale for developing the 2013 curriculum, which mandates that learning be carried out oriented to the development of students' critical thinking skills (Wanelly & Fitria, 2019; Zahrawati, 2020). Thus, each learning activity is oriented towards improving students' critical thinking skills. This includes learning mathematics.

Learning mathematics has a function to foster critical thinking skills (Adhetia, 2018). As the characteristics of mathematics subjects who study systematic thinking patterns, consistent with the system, proof based on definitions and axioms, clear, and accurate (Hendriana et al., 2019). So that when students learn mathematics, they learn to think critically.

Although it has been explained that mathematics learning activities can equip students with critical thinking skills, in reality, this has not been fully realized in Indonesia. As the results of the International Trends in International Mathematics and Science Study (TIMSS) which states that students in Indonesia are consistently ranked at the bottom. Indonesian students were in the bottom seven of 45 countries in 2015 and four years later, in 2019, Indonesian students were still in the bottom five of 50 countries (Rastuti & Prahmana, 2021). From these problems, students' critical thinking skills are important to become the object of research.

Based on the results of observations at MTs Asadiyah in Wajo Regency, there are four indicators of critical thinking skills: interpretation, analysis, evaluation, and decisions. Students are only at the interpretation stage, which can describe the meaning of the geometric mathematical problem, but they have not been able to plan problem solving (analysis) and determine methods for solving existing problems (evaluation). Students have difficulty solving problems in the form of story questions and pictorial questions, especially those that are a combination of 2D shapes.

By seeing these problems, efforts are needed to cultivate students' critical thinking skills in solving geometric problems. Based on the theory of Van Hiele (1959), when a student studies geometry, there are five stages of thinking levels that will be passed by the child, namely visualization, analysis, abstraction, deduction, and rigor (Crowley, 1987). Several researchers have studied this, including Pujawan et al., (2020) which concludes that a characteristic of Van Hiele's level of thinking is the speed to move from one level to the next is more influenced by activities in learning. Thus, the organization of learning, content, and materials is an important factor.

This is in line with the research of Andila & Musdi (2020) which concludes that teachers play an important role in encouraging speed to move through a level. Higher levels of thinking can only be achieved through a learning process that is connected with things that students often encounter every day so that they can understand the properties of concepts and identify geometric shapes based on an informal analysis of their parts and attributes. As the results of Adhetia & Suhartini's research (2018) concluded that geometry learning that uses local culture as a learning medium can grow students' critical thinking skills.

Learning innovation using cultural contexts is very important to grow students' critical thinking skills because in the teaching process the material will be linked to things that students often encounter every day so that they can identify and relate parts of culture as a medium for learning geometry mathematics (Fitri & Prahmana, 2020). Thus, the selection of learning activities that are under the students' thinking stage is absolutely necessary to help students reach higher thinking stages (Lailatul Fitri & Prahmana, 2020).

Various previous studies have found that learning mathematics in a local context can make it easier for students to understand the material being taught and improve their critical thinking skills (Busrah & Pathuddin, 2021; Sutarto et al., 2021; Risdiyanti et al., 2019; Heris Hendriana et al., 2019; Risdiyanti & Prahmana, 2020; Prahmana, 2015; Lailatul Fitri & Prahmana, 2020; Prihastari, 2015; Supiyati et al., 2019 Pujawan et al., 2020). Pathuddin et al., (2021) has explored the Burongko Bugis cake as a source of learning mathematics which concluded that making Burongko involves mathematical concepts such as division, congruence and similarity, as well as triangular prisms. But so far, there has been no research that aims to develop a trajectory of learning mathematics in a Burongko cake to help students understand the concept of quadrilaterals and develop their critical thinking skills.

Based on this, the purpose of this research is to design local instruction theory of geometry learning to use Burongko Bugis cake media as a local context based on Van Hiele's theory to improve students' critical thinking skills. In addition, this study also aims to describe the profile of students' critical thinking skills according to Van Hiele's level of thinking after the learning process.

From this research, the benefits got are the creation of a learning trajectory of rectangular shapes with the context of a Burongko cake that can be used by teachers in helping students understand the concept of rectangular flat shapes and develop their critical thinking skills.

Methods

The method used in this research was design research which aimed to build a learning trajectory of quadrilaterals to improve learning activities in the classroom and improve students' critical thinking skills by conducting interactive analysis of the allegations of what is happening in the classroom and its implementation (Akker, Gravemeijer, McKenney, & Nieveen, 2006). There are three stages in this research, namely: the design stage, the experimental stage, and the analysis stage. At the design stage of the Hypothetical Learning Trajectory (HLT), a literature review was conducted on learning models with a cultural context based on Van Hiele's theory. The results are as developing learning activity designs to achieve the learning objectives that have been made at each stage, namely building a relationship between the objectives of each learning stage, indicators, and the conjecture of each activity. The resulting learning design is known as a hypothetical learning trajectory (HLT), which is then validated by experts. The conjecture of HLT is planned on learning objectives, learning activities, and tools to assist the learning process. Next, the experimental design stage. At this stage, the hypothetical learning trajectory that has been designed is tested, then the researcher observes and analyzes the learning activities that occur during the learning process in the classroom. This process aims to evaluate the conjectures in the learning activity. All teaching trials were recorded using photo documentation. The students' work was collected for analysis and several students were selected to be interviewed. The last stage is analysis. After the experimental design stage, the data got from the learning activities and students' critical thinking skills were analyzed to evaluate the success of the learning activities that had been implemented. The results a local instruction trajectory for learning to construct a rectangular flat shape using the context of the Bugis Burongko cake. The subjects of this study were the class VII students of MTs As'adiyah Bontouse, totaling 23 students and then two students were selected, each of whom had high and low mathematical abilities, which were got after the learning process. Each subject was asked to describe his mental activity in solving a problem. This is done to explore the subject's critical thinking process and other solutions that cannot be seen in the students' written work. The data got were analyzed retrospectively with HLT.

Results

Stage 1: Design Hypothetical Learning Trajectory (HLT)

In the Design Hypothetical Learning Trajectory stage, the researcher implemented the initial idea of using the traditional Burongko Bugis cake context in learning trapezoidal shapes. This Burongko cake was chosen based on the results of preliminary research that had been carried out by Pathuddin et al., (2021), which stated that in the Burongko cake, there was an implementation of the concept of a trapezoidal flat shape. Besides that, Burongko cake contains philosophy and cultural values that have implied meanings, so it is a traditional cake that is always served in every traditional event such as weddings, *mabarasanji*, *menretojang*, *matampung*, etc. So that it can shape the character of students who are cultured (Pathuddin et al., 2021).

The development of HLT in every learning activity is the most important part in designing student learning activities. The design is inseparable from the learning trajectory, which contains a lesson plan for the material to be taught. Here, the learning trajectory is a concept map that will be passed by students during the learning process. The learning trajectory used in this study is an understanding of the concept of a flat trapezoid using the context of the Burongko cake. After that, students are expected to have a level 4 geometric thinking level at the rigor Stage based on Van Hielle's level of thinking, namely being able to grow critical thinking skills by reflecting or evaluating the problem solving given.

A collection of trapezoidal learning activities based on the learning trajectory and students' thinking results are hypothesized in HLT. It aims to achieve students' understanding of the trapezoid concept, foster critical thinking skills in solving problems encountered in everyday life. The following is a trapezoidal learning conjecture using the Burongko cake context in Table 1.

Table 1. Trapezoidal Conjecture Learning Using the Context of Burongko Cake

Teacher Activities	Activity Description	Conjecture	Critical Thinking Ability
Phase I: Visualization	Show students examples of trapezoidal shapes (traditional Bugis cakes that students often encounter, such as Burongko).	Pay attention to the objects shown by the teacher.	Interpretation
	Ask students a problem regarding traditional cakes.	With the learning experience students are expected to be able to understand or express	

		ideas and meanings in the form of a given geometric problem.	
Phase II: Analysis	Asking students to analyze the elements in the traditional cakes shown	Students are asked to find relationships from data and information based on the problems given with the knowledge and experience they have to solve these problems.	Analysis
Phase III: Informal Deduction	Asking students to relate ideas, the properties of the spatial structure to the given problem.	Ask students to associate appropriate data and information. Carry out experiments. Solve problems according to plan	Evaluation
Phase IV: Formal Deduction	Ask students to construct proofs, look for more than one method of proof, and explain the importance of proving theorems through deductive reasoning.	Students check the solutions provided. And trying to find other solutions in solving problems through deductive reasoning.	Decision
Phase V: Rigor	Ask students to relate mathematical concepts to local cultural values based on problem solving.	Reflect or evaluate problem solving. Looking for community activities related to the structure of space and the meaning contained therein.	Decision and conclusion

Stage 2: Design Experiment

At this stage, the researcher conducted an experimental learning trajectory that had been previously designed for class VIII MTs As'Adiyah No. 2 Bontouse. Then an analysis of the experimental results got in the experimental design stage was carried out. There are 5 activities carried out in the experimental design stage which are classified into several stages, namely visualization, analysis, formal deduction, informal deduction, and rigor.

Stage 1: Visualization.

At this stage the activity carried out is to show students examples of flat shapes related to the trapezoid concept (traditional Bugis cakes such as Burongko). The teacher starts the lesson by asking students questions about the culture around them, one of which is traditional Bugis cakes. Then students mention the kinds of traditional cakes they know that are often served. Next, the teacher asked whether the students knew Burongko cake and asked the meaning contained in the presentation of Burongko cake in traditional events such as weddings, *mabarasanji*, *menretojang*, *matampung,* and so on. Next, the teacher tells the philosophy and meaning contained in the presentation of Burongko cake in a traditional event to form a cultured student character. After that, to get a common perception of the students, the teacher asked the students to draw Burongko cakes freely according to the understanding in the students' minds.

After students finished drawing Burongko cakes freely, then the teacher together with students practiced again how to draw Burongko cake shapes to get the same perception. This is done to facilitate the implementation of activities in the next stage.

At this stage, students are familiar with the shape of the Burongko cake because it is often found in the presentation of traditional events such as weddings, mabarasanji, menretojang, matampung and so on. So that students are easy to imagine and describe it. At the time of drawing the shape of the Burongko cake, the students did not realize and understand that in drawing the shape the student had made a trapezoidal shape as a part of forming the image of the Burongko cake. This understanding is developed by discussing with students and posing a problem related to the shape of the Burongko cake, which is a trapezoid. The end result, students are able to develop their critical thinking skills, namely the indicators of interpretation.

Stage 2: Analysis

The activity carried out at this stage is asking students to analyze the elements in the Burongko cake that have been drawn based on the problems given in the previous stage. Students are asked to find relationships from data and information based on the given problem with the knowledge and experience they have to solve the problem.

Stage 3: Informal deduction

Activities carried out at this stage, students connect ideas, properties of flat shapes with the problems given. Ask students to associate data and information and solve problems according to plan.

Stage 4: Formal deduction

The activities carried out at this stage ask students to compile proofs, look for methods of proving over one way, and explain the importance of proving theorems through deductive reasoning. Students check the solutions provided and trying to find other solutions in solving problems through deductive reasoning.

Stage 5: Rigor

Activities carried out at this stage are asking students to associate mathematical concepts with local cultural values based on problem solving, reflection, or evaluation of problem solving. Looking for community activities related to the form of space and the meaning in it.

Stage 3: Analysis

Description of students' critical thinking skills

Data on students' critical thinking skills were got by using a critical thinking ability test. This test is given before and after applying mathematics learning in an ethnomathematical context. The results of students' critical thinking skills in class VIII B are described based on the results of the pretest and posttest. From the results of processing the data, it is got a data recapitulation of students' critical thinking skills based on the absorption of each indicator of critical thinking skills, which is presented in Table 2.

Table 2. Recapitulation of the Absorbability of Students' Critical Thinking Ability from Each Indicator

Critical Thinking Ability	Pretest	Posttest	Enhancement
Interpretation	48.60%	100%	51.40%
Analysis	11.70%	99%	87.30%
Evaluation	1.44%	93%	91.56%
Decision	0.00%	35%	35%

Based on Table 2, it can be seen that the absorption of students' critical thinking skills from the interpretation indicators on the pretest score of 48.60% and the posttest score of 100%, so that there is an increase in absorption of 51.40%, after the learning process. The absorption of students' critical thinking skills from the analysis indicators at the pretest score of 11.70% and the posttest score of 99%, resulting in an increase in absorption of 87.30%. The absorption of students' critical thinking skills from the evaluation indicators at the pretest score was 1.44% and the posttest score was 93%, resulting in an increase in absorption capacity of 91.56%. The absorption of students' critical thinking skills from the decision indicators at the pretest score of 0.00% and the posttest score of 35%, resulting in an increase in absorption of 35%. The four problem solving indicators, namely interpretation, analysis, evaluation, and decisions, the highest absorption increase in the evaluation indicator is 91. 56%.

The categories of students' pre-test and post-test learning outcomes were grouped into 5 categories using a scale prepared by the Ministry of Education and Culture of Wajo Regency, so that the frequency distribution and presentation were got as shown in Table 3.

Table 3. Distribution of Frequency and Percentage of Students' Mathematical Critical Thinking Ability

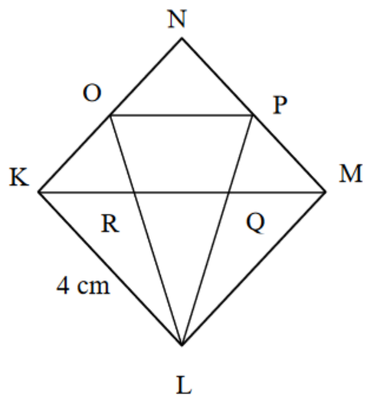
Interval	Student Ability Category	*Pre-test*		*Post-test*	
		Frequency	Percentage (%)	Frequency	Percentage (%)
90-100	Very high	0	0.0	6	24.00
80-89	High	0	0.0	9	36.00
70-79	Medium	0	0.0	7	28.00
55-69	Low	0	0.0	3	12.00
0-54	Very low	25	100	0	0
Total		25	100	25	100

Table 3 shows that of the 25 students who were the research subjects, the pretest scores were in the very low category before learning, where all students scored in the 0-54 interval. This means that the initial ability of students' critical thinking is very low. Meanwhile, in the posttest of 25 students, 6 students were in the very high category, 9 students were in the high category, 7 students were in the medium category, and 3 students were in the very low category after learning to wake up in the Burongko cake context.

Data Exposure of LT Critical Thinking Ability Test Results and Interview Results Data According to Van Hiele's Thinking Level

Question

Take a look at the image below!

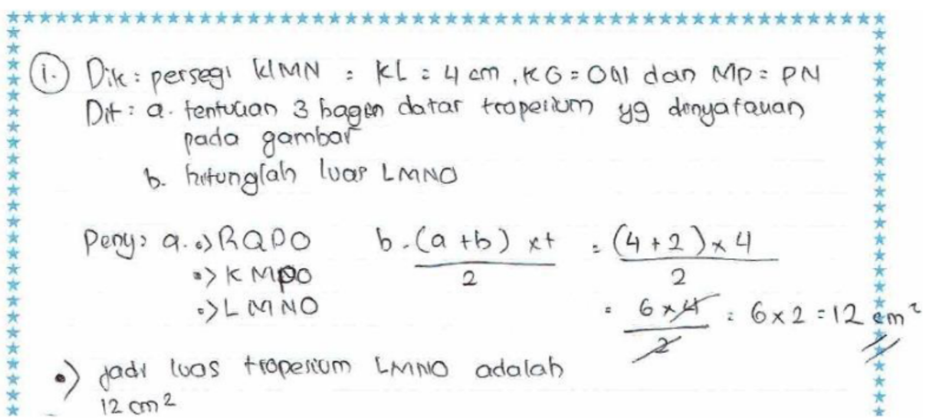


KLMN represents a square shape with KL = 4cm, KO = ON and MP = PN.

a. Determine the three trapezoidal shapes shown in the figure!

b. Calculate the area of LMNO!

Subject answer:



From the results of TPMG-01, the description of problem solving according to Polya's problem solving steps on LT subjects according to Van Hiele's level of thinking is stated:

Interpretation

In this indicator, the LT subject already understands the matter. This can be seen from the way the LT subjects write the things they know about the questions. It is known that KLMN is a square, with length KL = 4 cm, KO = ON and MP = PN. LT subjects can relate information that is interrelated to the question either from pictures or written information. The LT subject also clearly knows what is being asked from TPMG-01, namely (a) determining the 3 trapezoidal shapes stated in the KLMN image, and (b) calculating the area of the LMNO trapezoid.

Analysis

In this indicator, the LT subject answers the question part a by paying attention to the trapezoidal pictures in the KLMN image, while for the question part b uses the trapezoid area formula to find the area of the LMNO. The formula is $\frac{a+b}{2} \times t$. He used this formula because, previously, the LT subject had studied the quadrilaterals and the use of the area formula.

Evaluation

In this indicator, the LT subject solves the problem (question part b) by first looking for the parallel sides and the height of the LMNO trapezoid by linking the information in the problem. This can be seen clearly from the answer of TPMG-01. Subject LT wrote that the parallel sides of the LMNO trapezoid are 2 cm and 4 cm, respectively, while the height is 4 cm. Then put into the formula for the area of the trapezoid, so that the area of the trapezoid LMNO = 12 cm^2.

Decision

In this indicator, the LT subject has retrace his answer by checking and rechecking every step he uses. The subject of LT is sure with the answers written, this can be seen from the answers that are reaffirmed that the area of the LMNO trapezoid is 12 cm^2.

The following explains test-based interview data for LT on TPMG-01. In this interview, a brief description of solving student geometry problems based on Polya's steps is presented.

Code	P/J	Interview Description
LT1-001	***P***	Have you ever got a question like this (question number 1) before?
LT1-001	***J***	It looks like it's about the olympics (while reading the questions)
LT1-002	***P***	What did Faqih think after reading question number 1?
LT1-002	***J***	I was asked to determine 3 trapezoidal shapes
LT1-003	***P***	Does Faqih have difficulty reading the questions?
LT1-003	***J***	Not too
LT1-004	***P***	Does Faqih clearly know the known elements of the problem? Try to mention !
LT1-004	***J***	Yes KLMN is a square. KL = 4 cm, KO = ON and MP = PN because KO is half the length of the side of the square, then KO = ON = MP = PN = 2 cm.
LT1-005	***P***	Are the questions given enough to find what is being asked? try to mention !
LT1-005	***J***	Yes, that's enough. The first one is asked for 3 flat trapezoidal shapes and the second is the area of LMNO.
LT1-006	***P***	Is Faqih able to recognize rectangular shapes based on the

Code	P/J	Interview Description
		images/shapes he sees?
LT1-006	***J***	Yes
LT1-007	***P***	Can Faqih give a name when faced with various kinds of rectangular shapes without realizing the properties of these flat shapes?
LT1-007	***J***	Yes, if the picture is clear

In the interpretation indicator, the LT subject can understand the problem because it can clearly state what is known, namely KLMN is a square, with a length of KL = 4 cm, KO = ON and MP = PN, because KO is half the length of the side of the square, then KO = ON = MP = PN = 2 cm (LT1-004). Then the LT subject also mentioned what was being asked in the question. First, 3 trapezoidal shapes were asked, and the second was the area of LMNO (LT1-005). The LT subject also mentioned that he could recognize rectangular shapes based on the images/shapes he saw and could give names when faced with various kinds of rectangular shapes without realizing the properties of the flat shapes.

Code	P/J	Interview Description
LT1-008	***P***	How does Faqih solve the problem?
LT1-008	***J***	For the question of part A, I first pay attention to the picture provided. The first trapezoid I saw was OPQR (pointing to the picture in the problem), then I looked for other trapezoidal shapes expressed in the KLMN quadrilateral. As for part b, I used the trapezoid area formula to find the area of the LMNO.
LT1-009	***P***	What is the formula for the area of a trapezoid?
LT1-009	***J***	$\frac{a+b}{2} \times t$ (a and b are the parallel sides of the trapezoid)
LT1-010	***P***	Did Faqih have difficulty in formulating the alleged solution to the problem? (try to express)
LT1-010	***J***	For problem part A, at first I had difficulty finding a trapezoidal image but after I looked at all pictures, I finally found all the trapezoid images expressed in the KLMN square, while for part b I don't think I found any difficulties.

In the analysis indicators, the LT subject in solving part A questions first pays attention to the pictures provided. The first trapezoid he saw was OPQR (pointing to the picture in the problem), then he looked for other trapezoidal shapes expressed in the KLMN quadrilateral. As for part B, subject LT uses the trapezoid area formula to find the area of LMNO. The formula for the area of a trapezoid is $\frac{a+b}{2} \times t$ (a and b are parallel sides of a trapezoid). (LT1-009)

Code	P/J	Interview Description
LT1-011	***P***	What are the steps to solve the problem? (Try to explain)
LT1-011	***J***	For part A, I think it's enough to look at the picture to get the answer. As for the problem part b, that is by first finding the parallel sides and the height of the LMNO. The base of the LMNO trapezoid is LM, because KLMN is a square, meaning all sides are the same, meaning LM = 4cm. Then the upper side of the trapezoid LMNO is NO, because KO=ON means NO = 2cm half of KN. The height of LMNO is MN, which is 4 cm.

Code	P/J	Interview Description
		Continue to be entered the formula for the area of the trapezium.
LT1-012	***P***	Can Faqih prove every step used is correct?
LT1-012	***J***	Erm, yes (while looking at the answer sheet)
LT1-013	***P***	Is the formula used by the Faqih correct?
LT1-013	***J***	Yes, I think it's correct

In the evaluation indicators according to the plan, the LT subject in solving the problem first looks for sides that are parallel and high in LMNO. LT's subject said that the base of the LMNO trapezoid is LM, because KLMN is a square, meaning that all of its sides are the same length, meaning LM = 4cm. Then the upper side of the trapezoid LMNO is NO, because KO=ON means NO = 2 cm half of KN. The height of LMNO is MN, which is 4 cm. From the way of mentioning each side of the KLMN shape, it can be seen that the LT subject can relate every information in the question. In the next step, the subject of LT substituted the parallel sides and height of LMNO into the trapezoid formula (LT1-011) and got the area of the trapezoid LMNO = 12 cm^2.

Code	P/J	Interview Description
LT1-014	***P***	Is Faqih sure of the answer he got? Look again at the answer!
LT1-014	***J***	Yes, I'm sure (while checking answers)
LT1-015	***P***	If it's a question like this, is there any other way of solving it?
LT1-015	***J***	I don't think there is

In the decision indicator, the subject of LT has retraced the answer and is confident with the execution, he is sure that every step used is correct (LT1-014). The following contains information about the validity/consistency of data on solving geometry problems between the test method (TKBK) and the interview method (HW) 31 9 in solving geometry problems according to Van Hiele's level of thinking. The full description can be seen in Table 4.

Table 4. Comparison of students' critical thinking abilities between test results data and interview results data for male subjects with high mathematical ability (LT) according to Van Hiele's Thinking Level

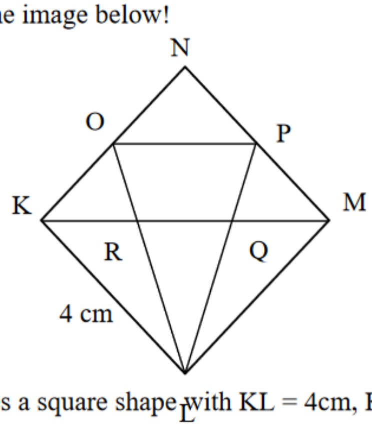
TKBK	HW
Interpretation	
The subject of LT already understands the matter. This can be seen from the way the LT subject wrote things that were known in the problem, namely that KLMN is a square, with a length of KL = 4 cm, KO = ON and MP = PN. The LT subject also wrote what was asked of the TPMG-01, namely (a) determining the 3 trapezoidal shapes stated in the KLMN image, and (b) calculating the area of the LMNO trapezoid.	LT subjects understand the question because they can clearly state what is known and what is being asked. What is being asked in this question is that KLMN is a square with KL = 4 cm, KO = ON and MP = PN, because KO is half the length of the side of the square, then KO = ON = MP = PN = 2 cm. Then the LT subject also mentioned the things that were asked in the question, namely the first to be asked for 3 flat trapezoidal shapes and the second the area of LMNO (LT1-

TKBK	HW
	004).
Analysis	
LT subjects use the formula for the area of a trapezoid $\frac{a+b}{2} \times t$ to find the area of LMNO. He used this formula because, previously, the subject of LT had studied the quadrilaterals and the use of the area formula.	LT subjects used the trapezoid area formula to find the area of LMNO (LT1-008). The formula for the area of a trapezoid is $\frac{a+b}{2} \times t$ (a and b are parallel sides of a trapezoid).
Evaluation	
LT subjects look for the parallel sides and the height of the LMNO trapezoid. Subject LT wrote that the parallel sides of the trapezoid LMNO were 2 cm and 4 cm, respectively, while the height was 4 cm. Then put into the formula for the area of the trapezoid, so that the area of the trapezoid LMNO = 12 cm^2.	LT subjects first look for the parallel sides and the height of LMNO. LT's subject said that the base of the LMNO trapezoid is LM, because KLMN is a square, meaning that all of its sides are the same length, meaning LM = 4cm. Then the upper side of the trapezoid LMNO is NO, because KO=ON means NO = 2cm half of KN. The height of LMNO is MN, which is 4 cm. Continue to be entered the formula (LT1-011) and the area of the trapezoid LMNO = 12 cm^2 is got.
Decision	
The LT subject has retired the answer and is confident in the workmanship. It can be seen from the answer that reaffirmed that the area of the LMNO trapezoid is 12 cm^2.	LT subject has traced back the answer and is confident with the workmanship. He is sure that every step used is correct (LT1-014).

Data Exposure of Critical Thinking Ability Test Results PR and Interview Results Data According to Van Hiele's Thinking Level

Question

Take a look at the image below!

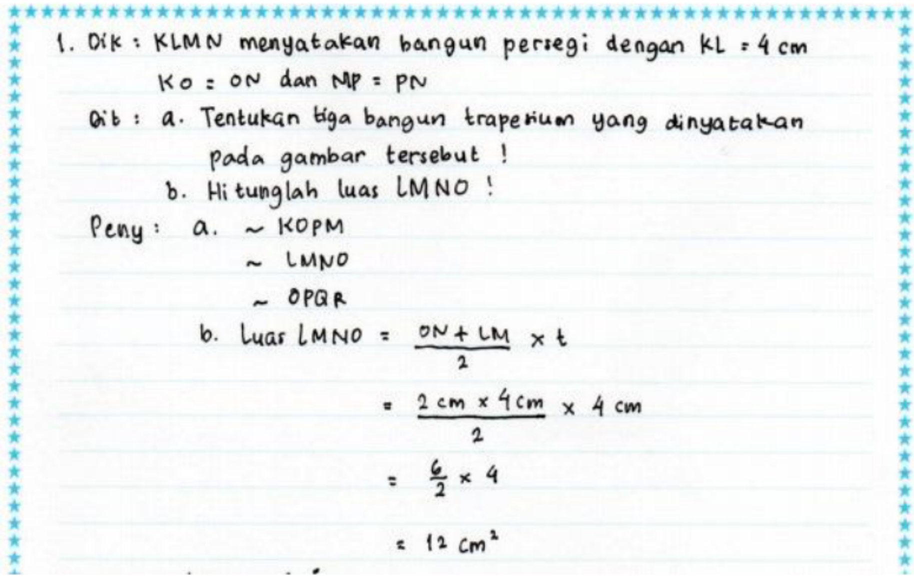


KLMN expresses a square shape with KL = 4cm, KO = ON and MP = PN

a. Determine the three trapezoidal shapes shown in the figure!

b. Calculate the area of LMNO!

Subject's answer:



1. Dik : KLMN menyatakan bangun persegi dengan KL = 4 cm
   KO = ON dan MP = PN

   Dit : a. Tentukan tiga bangun trapesium yang dinyatakan pada gambar tersebut !
   b. Hitunglah luas LMNO !

   Peny : a. ~ KOPM
   ~ LMNO
   ~ OPQR

   b. Luas LMNO $= \frac{ON + LM}{2} \times t$

   $= \frac{2\ cm \times 4\ cm}{2} \times 4\ cm$

   $= \frac{6}{2} \times 4$

   $= 12\ cm^2$

From the results of TPMG-01, the description of problem solving according to Polya's problem-solving steps about PR, according to Van Hiele's level of thinking, is stated:

Interpretation

In this indicator, the subject of PR has understood the matter. This can be seen from the way the subject of PR writes the information that is known about the problem. The things that are known are that KLMN expresses a rectangular shape with length KL = 4 cm, KO = ON and MP = PN. The PR subject also clearly knows what is being asked from TPMG-01, namely (a) determining the 3 trapezoidal shapes stated in the KLMN image, and (b) calculating the area of the LMNO trapezoid.

Analysis

In this indicator, the PR subject determines 3 trapezoidal shapes by analyzing the images stated in the KLMN (part a) and using the trapezoid area formula to find the area of the LMNO (part b). PR subjects can plan problem solving by writing the formula for the area of the trapezoid LMNO is $\frac{LM+NO}{2} \times t$.

Evaluation

In this indicator, the PR subject solves the problem (question part b) by first looking for the parallel sides and the height of the LMNO trapezoid by linking the information in the problem. This can be seen clearly from the answer to TPMG-01. The PR subject wrote that the parallel sides of the LMNO trapezoid are 2 cm and 4 cm, respectively, while the height is

4 cm. Then put into the formula for the area of the trapezoid, so that the area of the trapezoid LMNO = 12 cm^2.

Decision

In this indicator, the subject of PR has retraced his answer by re-checking every step he uses. The subject of PR is sure with the answer written, that the area of the LMNO trapezoid is 12 cm^2.

The following is an explanation of test-based interview data for PR on TPMG-01. In this interview, a brief description of solving student geometry problems based on Polya's steps is presented.

Code	P/J	Interview Description
PR1-001	***P***	What did Tarizha think after reading question number 1?
PR1-001	***J***	I'm surprised because I've never had a question like this before.
PR1-002	***P***	Does Tarizha have difficulty reading the questions?
PR1-002	***J***	Ehm, I have no difficulty in reading the question.
PR1-003	***P***	Does Tarizha know the known elements of the problem? Try to mention !
PR1-003	***J***	He knows. KLMN expresses a rectangular shape with length KL = 4 cm, KO = ON and MP = PN.
PR1-004	***P***	Are the questions given enough to find what is being asked?
PR1-004	***J***	That's enough
PR1-005	***P***	Try to mention
PR1-005	***J***	Part A determines the 3 flat shapes of the trapezoid as shown in the KLMN drawing, while part b calculates the area of the LMNO trapezoid.
PR1-006	***P***	Is Tarizha able to recognize quadrilaterals based on the pictures/shapes he sees?
PR1-006	***J***	Yes I can
PR1-007	***P***	Can Tarizha give a name if he is faced with various kinds of quadrilaterals without realizing the properties of the flat shapes?
PR1-007	***J***	Yes I can

In the interpretation indicator, the PR subject understands the problem because it can clearly state what is known, namely KLMN states a rectangular shape with a length of KL = 4 cm, KO = ON and MP = PN (PR1-003). Then the PR subject also mentioned that what was asked in the question was first to determine the 3 flat shapes of the trapezoid as stated in the KLMN picture and the second was the area of LMNO (PT1-004). She can give names when faced with various kinds of quadrilaterals without realizing the properties of these flat shapes.

Code	P/J	Interview Description
PR1-008	***P***	How does Tarizha formulate the solution to this problem?
PR1-008	***J***	For part A questions, by looking at the shape, if part A uses the trapezoid area formula
PR1-009	***P***	Did Tarizha have difficulty in formulating the alleged solution to the problem? (Try to express)
PR1-009	***J***	Yes, when looking for a trapezoidal shape, it's not too difficult to

Code	P/J	Interview Description
		find the area because it's enough to use the formula
PR1-010	***P***	Where is it difficult to find a trapezoidal shape?
PR1-010	***J***	It's been a long time looking for a trapezoid

In the analysis indicators, the subject of PR can formulate problem solving well. For part A, the PR subject determined 3 trapezoidal shapes by looking at the pictures stated in the KLMN, although initially they had difficulty finding the trapezoidal shapes stated in the KLMN. Meanwhile, for part b, the formula for the area of the trapezoid is used to find the area of LMNO (PR1-008).

Code	P/J	Interview Description
PR1-011	***P***	What are the steps to solve this problem? Explain!
PR1-011	***J***	For part B, that is, by using the formula for the area of a trapezoid $\frac{LM+NO}{2} \times t$. Then enter the numbers and get the area of LMNO 12 cm^2
PR1-012	***P***	Can Tarizha prove every step used is correct?
PR1-012	***J***	Ehm, yes (while looking at the answer)
PR1-013	***P***	Is Tarizha sure that the formula used is correct?
PR1-013	***J***	Yes

In the evaluation indicator, the PR subject solves the problem by substituting the parallel sides and the height of the LMNO trapezoid into the formula, namely $\frac{LM+NO}{2} \times t$. So that the area of LMNO = 12 cm^2 (PR1-011).

Code	P/J	Interview Description
PR1-014	***P***	Is Tarizha sure about the answer he gets?
PR1-014	***J***	Yes, I am sure
PR1-015	***P***	Is there any other way to solve a problem like this?
PR1-016	***J***	There is no

The decision indicator, the subject of PR, has re-examined the answer and is confident with the work. She is sure that every step used is correct and there is no other way to solve the problem (PT1-016).

Discussion

5 Students' understanding of the material of quadrilaterals can be supported by the design of the learning trajectory using the Burongko cake context, which comprises six learning activities. The first activity (visualization) students can analyze the quadrilaterals by asking students to draw Burongko cakes freely according to the understanding 1 that is in students' minds. At the time of drawing the shape of the Burongko cake, students did not realize and understand that in drawing the shape, the student had made a flat trapezoid shape as a part of forming the image of the 4 Burongko cake. This understanding was developed by discussing with students and posing a problem related to the shape of the Burongko cake, namely the trapezium. The result, students can develop their critical thinking skills, namely 42 on indicators of interpretation, so students think that the context of Burongko cake can be applied in learning mathematics.

Based on the use of the Burongko cake context, students can easily analyze the quadrilaterals. This is in line with the results of research Lestari et al., (2021) which reveals that the use of context has a positive impact on the learning process to be more enjoyable so that students are more active and make students not think that mathematics is abstract. In addition, learning to build a quadrilateral with the context of Burongko cake can also improve students' critical thinking skills and shape students' character. For example: self-confidence, sympathy, empathy, respect for others, awareness of social problems and social spirit, and responsibility.

Then, in the second activity (analysis), students analyze the elements as Burongko cake that have been drawn based on the problems given in the previous stage. Students are asked to find relationships from data and information based on the problems provided with the knowledge and experience they have to solve these problems. From this activity, students can find out how many trapezoidal shapes are in the problem and find the formula for the area of a trapezoidal quadrilateral.

In the third activity, students associate data and information and solve problems according to plan. In the fourth activity, students construct proofs, look for methods of proving over one way to get the formula for the area of a trapezium, and explain the importance of proving theorems through deductive reasoning. Students check the solutions provided. And trying to find other solutions in solving problems through deductive reasoning. In the fifth activity (Rigor) students associate mathematical concepts with local cultural values based on problem solving. Reflecting or evaluating problem solving. Looking for community activities related to quadrilaterals, and the meanings contained.

Students' understanding of the concept of quadrilaterals and critical thinking skills became better after learning flat shapes in Burongko Bugis cake. Students can understand mathematical concepts easily, fun, close to students' daily activities and can be imagined. It also makes it easier for students to solve given problems related to daily activities. In addition, the application of the Local Instruction Trajectory in a Burongko cake can shape the character of students, such as self-confidence, sympathy, empathy, respect for others, awareness of social problems and a social spirit, and responsibility. These results support several previous research results which state that learning activities related to daily activities, namely ethnomathematics can be a starting point in learning mathematics (Risdiyanti et al., 2019; Heris Hendriana et al., 2019; Risdiyanti & Indra Prahmana, 2020; Prahmana, 2015; Lailatul Fitri & Prahmana, 2020; Prihastari, 2015; Supiyati et al., 2019; Pujawan et al., 2020).

Students' critical thinking skills in solving rectangular shape problems after the learning process using the ethnomathematical context, there was no significant difference in the geometric problem-solving process between students who had high and low knowledge. However, subjects with high mathematical abilities could carry out critical thinking processes to solve problems much better than subjects with low mathematical abilities. This is because in the learning process mathematical concepts are associated with students' daily habits so that they are enthusiastic, active in the learning process, and critical in responding to the problems given. This finding strengthens the results of previous research conducted by Adhetia & Suhartini (2018) which concluded that ethnomathematical-based mathematics learning has relevance to indicators of critical thinking skills which include interpretation, analysis, evaluation, and decision making. This is in line with several previous research findings which concluded that students' critical thinking skills can be improved by using ethnomathematical-based geometry materials in the learning process (Sumiyati et al., 2018; Mirnawati et al., 2020; Suherman et al., 2021). Thus, ethnomathematics-based mathematics learning can be used as an alternative for learning mathematics to develop students' critical thinking skills.

Teachers in learning mathematics, especially in teaching geometry material, try not only to understand concepts but also need to develop students' critical thinking skills. Because in studying geometry, not only geometry skills are needed but also several abilities, such as the ability to interpret, analyze, evaluate and make decisions, and this ability is an indicator of critical thinking skills.

Conclusion

Based on the results and discussion, it can be concluded that the design of the learning trajectory of flat shapes in an ethnomathematical context based on Van Hielle's theory has relevance to indicators of critical thinking skills which include interpretation, analysis, evaluation, and decision making. In addition, this learning trajectory can increase students' understanding of the concept of quadrilaterals easily and pleasantly. This is because, in the learning process, mathematical concepts are associated with students' daily habits so that they are enthusiastic, active in the learning process, and critical in responding to the problems given. In addition, the application of the Local Instruction Trajectory in a Burongko cake can shape the character of students, for example, self-confidence, sympathy, empathy, respect for others, awareness of social problems and a social spirit, and responsibility. The profile of students' critical thinking skills in solving rectangular problems after the learning process using an ethnomathematical context. From the results of qualitative analysis, it was found that there was no significant difference in the geometric problem-solving process between students who had high and low knowledge. Both research subjects have good interpretive skills, have problem analysis skills, can evaluate, and decide to get the right answer. However, subjects with high mathematical abilities could carry out critical thinking processes to solve problems much better than subjects with low mathematical abilities. With the Local Instruction Trajectory, the teacher can optimize learning to build a quadrilateral, while equipping students with critical thinking skills. This learning trajectory is only for quadrilaterals, so it is necessary to develop a wider mathematics learning trajectory within a local context.

Conflicts of Interest

The authors declare that no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely by the authors.

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