

STUDENTS' MATHEMATICAL REASONING: HOW COULD IT BE THROUGH MHM-PROBLEM BASED STRATEGY AIDED INTERACTIVE MULTIMEDIA?

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Abstrak

Penelitian ini bertujuan untuk mengetahui kemampuan penalaran matematis siswa yang memperoleh pembelajaran Mathematical Habits of Mind-Problem Based Strategy (MHM-PB) berbantuan multimedia interaktif, untuk mengetahui pengaruh MHM-PB terhadap kemampuan penalaran matematis siswa berdasarkan jenis kelamin, dan untuk menganalisis kesulitan siswa dalam menyelesaikan tes kemampuan penalaran matematis. Penelitian ini dilakukan dengan menggunakan metode eksperimen semu dengan desain kelompok kontrol *pre-test* dan *post-test*. Data diperoleh dari 66 siswa kelas VII di Kabupaten Indramayu, Indonesia, dengan menggunakan lima soal tes uraian terkait kemampuan penalaran matematis. Strategi MHM-PB berbantuan Multimedia Interaktif digunakan di kelas eksperimen dan kelas lainnya memperoleh pembelajaran konvensional. Hasil penelitian menunjukkan bahwa penalaran matematis siswa yang menggunakan strategi MHM-PB berbantuan multimedia interaktif lebih baik dibandingkan dengan strategi konvensional. Tidak terdapat perbedaan kemampuan penalaran matematis berdasarkan jenis kelamin pada siswa yang menggunakan strategi MHM-PB. Selain itu, beberapa siswa masih mengalami kesulitan dalam membuat kesimpulan, memberikan alasan atau bukti atas jawaban yang mereka berikan, dan memeriksa kebenaran suatu pernyataan. Sementara itu, membuat generalisasi merupakan kesulitan yang banyak dialami siswa.

Kata kunci: *Habits of mind*; multimedia interaktif; penalaran matematis.

Abstract

This study aims to determine students' mathematical reasoning ability using Mathematical Habits of Mind-Problem based Strategy (MHM-PB) strategy aided interactive multimedia, to analyze the effect of using MHM-PB on mathematical reasoning abilities based on gender differences, and to analyze students' difficulties in solving mathematical reasoning ability tests. This research was carried out using the quasi-experimental method with pre-test and post-test control group design. Data were obtained from 66 grade VII students at Indramayu Regency, Indonesia using an essay test with five problems on mathematical reasoning ability. Mathematical Habits of Mind-Problem Based Strategy aided Interactive Multimedia is used in experimental group and the other group received conventional strategy. The result showed that students' mathematical reasoning using MHM-PB strategy aided interactive multimedia was better than the conventional strategy. There is no difference in mathematical reasoning abilities based on gender in students who use MHM-PB. Furthermore, some students still have difficulty making a conclusion, providing reasons or evidence for the answers they give, and checking the truth of a statement. Meanwhile, making generalizations is a difficulty that many students experience.

Keywords: *Habits of mind*; Interactive multimedia; Mathematical Reasoning



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INTRODUCTION

Reasoning is a process of thinking to draw logical conclusions from facts, information in various ways that truth is recognized. According to Tanisli (2016) and Rizqi & Surya (2017), reasoning is a thinking process used to make conclusions or make a new statement based on prior information. Meanwhile, Yanto et al. (2019) stated that the process of reasoning includes linking evidence and facts to construct logical conclusions. Rohana (2015) specifically stated that mathematical reasoning is used to draw conclusions and solve mathematical problems based on logical and critical facts.

Reasoning also enables students to determine various ideas from facts or use various existing information to solve mathematical problems. According to the National Council of Mathematics Teachers (NCTM, 2000), mathematical activities are inseparable from reasoning because it plays a vital role in solving problems (Rohana, 2015; Napitupulu et al., 2016; Hasanah et al., 2019). Mueller & Maher (2009) stated that reasoning forms the basis of mathematical understanding. Therefore, it is needed by students in understanding, solving, and learning various mathematics concepts.

The importance of reasoning in mathematics learning activities is one of the objectives of teaching mathematics to students. To teach students the reasoning is one of the important goals in mathematics Jeannotte & Kieran (2017). After students learn the subjects at the primary and secondary education level, they are expected to possess mathematical reasoning, such as making generalizations, guesses and verifying them based on patterns, facts, phenomena, or existing data (Kemdikbud, 2017).

According to Isnaeni et al. (2018), students' mathematical reasoning ability is still low irrespective of the importance of possessing such a skill. This is in addition to the numerous studies on mathematical reasoning, which indicated low mathematical reasoning ability. The yearly results of the Program for International Students Assessment (PISA) test for the mathematics category from year to year, Indonesia's achievements are still lower than other participating countries (OECD, 2019; Nizam, 2016; Pratiwi, 2019). Furthermore, the Trends in International Mathematics and Science Study (TIMSS) study results from 1999 to 2015 (Nizam, 2016; Mullis et al., 2016) showed the same. Furthermore, several research results indicated differences in abilities between male and female students in their reasoning abilities. In language, female students are superior to males, but male students are superior in science and reasoning (Kuhn & Holling, 2009). Gender affects students' understanding of mathematics (Fajar, 2016). Male students have superior reasoning ability than female students (Setiawan & Sajidah, 2020).

Several other studies have shown various problems related to reasoning. The results showed that teachers had difficulty in generalizations (Moguel et al., 2019). Students can make mistakes in solving the problems analogies (K. Saleh et al., 2017). Students can make mistakes in every stage of reasoning. It performs mathematical manipulations and provides a reason or evidence to the truth of the solution, checking the validity of an argument and conclusion (Setiawan & Sajidah, 2020).

Habits are used to determine students' mathematical reasoning ability. According to Mahmudi & Sumarmo (2015), positive habits carried out by

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students consistently have the potential to form a variety of positive abilities. Furthermore, one of the strategies that emphasize students' thinking habits is the Mathematical Habits of Mind-Problem Based (MHM-PB). Learning with MHM-PB is integrating problem-based learning with the Mathematical Habits of Mind (MHM) strategy.

Jacobbe & Millman (2009) carried out research to determine students thinking habit in mathematics to 1) explore ideas, 2) formulate questions, 3) construct examples, 4) identify problem-solving approaches that are useful in large classes, 5) inquire about the possibility of "something more" (a generalization) in the content on which they are working, and 6) reflect on their answer to determine the possibility of errors known as MHM (Miliyawaty, 2014). Thus, the MHM strategy has the potential to develop students' thinking abilities maximally.

The Problem-Based Learning model has a procedure consisting of the following: 1) the teacher presents the problem to the students, 2) the students identify the given problem, 3) they seek information from various sources, 4) they choose the most appropriate solution, and 5) the teacher evaluates the students' work (Gorghiu et al., 2015). By paying attention to the procedures in Problem-Based Learning, the model promotes students to use their reasoning in solving problems.

Although studies are rarely conducted on the MHM-PB strategy, previous research indicates that students' creative thinking abilities can be improved through this process (Andriani et al., 2017; Mahmudi & Sumarmo, 2015). Furthermore, according to Mahmudi & Sumarmo (2015), students taught with the MHM

strategy perform better in terms of solving mathematical problems. In line with other studies show the impact of implementing MHM on children with challenging behaviors, such as increased task persistence, application of knowledge in facing new situations, listening to others with understanding and empathy, increased managing impulsivity, and thinking flexibly (Burgess, 2012).

Another factor supporting the implementation of teaching and learning is media, such as interactive multimedia. According to Khoiri et al. (2013), multimedia is a tool capable of creating dynamic and interactive presentations that combine text, graphics, animation, audio, and images. Thus, this research aims to examine:

- 1) Mathematical reasoning ability of students using MHM-PB strategy aided interactive multimedia.
- 2) The effect of using MHM-PB on mathematical reasoning abilities is based on gender differences.
- 3) Student's difficulties in answering tests related to mathematical reasoning ability.

METHOD

The method used in this research was quantitative with a quasi-experimental design. The random cluster sampling was used to obtain data from 66 grade VII students of Junior High School in Indramayu, West Java, Indonesia. The students were grouped into two equal classes with the same number of students, with one taught using MHM-PB strategy aided interactive multimedia and the other used conventional learning strategy.

Meanwhile, if viewed from gender, the subjects are 66 students consisting of 39 female and 27 male students. In the experimental group,

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there were 11 male students and 22 female students. In the control group, there were 16 male students and 17 female students.

In this study, MHM-PB strategy steps are:

- 1) The teacher explains the purpose of the following learning problem through a PowerPoint slide show, and students are directed to ask questions related to the problem.
- 2) Students gather information to solve problems in groups by defining and organizing learning tasks related to the problems.
- 3) The teacher encourages students to discuss in groups, conduct experiments, explore mathematical ideas, construct examples, and formulate hypotheses.
- 4) Students work on the report of solved problems by matching the answer to the solution on the slide.
- 5) The teacher helps students review the problem-solving results and evaluate the process by asking them to present their work.
- 6) Through discussion the teacher and students identify problem-solving strategies that can be applied to other problems.
- 7) The teacher and students conclude about the studied concept or material.

The instrument used was a test of mathematical reasoning ability, which consists of 5 essay questions and indicators as follows: 1) drawing conclusions, compiling evidence, providing reasons for the correctness of the solution, 2) Checking the truth of statement 3) Posing conjecture, 4) Finding patterns or properties of mathematical symptoms to make generalizations These indicators were based on trials' results valid and reliable tests with a reliability coefficient of 0,57.

To determine students' mathematical reasoning abilities, the results of the reasoning ability tests were used after the entire learning process ended. Furthermore, the formulation from Meltzer (2002) was used to determine the increase of mathematical reasoning ability. Meanwhile, Hake (1999) was classified gain is used to interpret Normalized Gain (N-gain). The normalized gain is obtained from the comparison between the difference between the pretest score and the posttest score with the difference between the ideal score and the pretest score, which can be written as follows.

$$N - \text{gain} = \frac{\text{posttest score} - \text{pretest score}}{\text{ideal score} - \text{pretest score}} \quad (1)$$

With interpretation: (a) high, if $N - \text{gain} \geq 0,70$; (b) moderate, if $0,30 \leq N - \text{gain} < 0,70$; (c) low, if $N - \text{gain} < 0,30$.

Furthermore, quantitative data were analyzed through inferential statistical analysis. In the inferential statistical analysis stage, several tests were used that correspond to the characteristics of the data (normally distributed, homogeneous). This stage is carried out to test the hypothesis proposed in the study. Prerequisite test of parametric statistics on mathematical reasoning abilities of students. The data are grouped based on learning and gender. The hypothesis tests used include two-way ANOVA test and continued with Scedge test'. Meanwhile, to analyze students' difficulties in solving problems related to mathematical reasoning can be seen from students' answers.

RESULTS AND DISCUSSION

Results of pre-test, post-test, and N-gain are shown in Table 1 and Table 2.

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Table 1. Results of pre-test, post-test, and N-gain in experiment group

	Experiment Group		
	Pre-test	Post-test	N-gain
Maximum score	11	19	0,94
Minimum Score	2	14	0,54
Mean	5,76	17,36	0,81
Standard Deviation	2,60	1,32	0,10

Table 2. Results of pre-test, post-test, and N-gain in control group

	Experiment Group		
	Pre-test	Post-test	N-gain
Maximum score	11	17	0,78
Minimum Score	2	11	0,25
Mean	5,73	13,88	0,57
Standard Deviation	2,23	1,82	0,14

Table 1 and Table 2 showed that the experiment group and control group post-test's result had difference mean of 3,48. This means that students' average mathematical reasoning ability in the experimental group is higher than control group, while the ideal maximum score is 20. Furthermore, based on the post-test results compared to the ideal maximum score, the average score for the experimental group is 86,8%, and the control group is 69,4%. This acquisition supports the differences in the increase in mathematical reasoning abilities between the two groups. The mean N-gain of the experiment group means a high increase. Meanwhile, the mean of N-gain of control group means on the moderate level based on (Meltzer, 2002) research.

Data processing was performed to test the normality of the N-gain data distribution using the Windows program SPSS. Therefore, based on Shapiro Wilk's test, it can be concluded that the normality of distribution is fulfilled, or the population is normally distributed. Levene's test indicates that the variance data is homogeneous. Thus, from two-way ANOVA test, it can be concluded

that the learning model has a significant effect on the increase of mathematical reasoning ability. This is indicated by the value of $F = 62,95$ with the probability (sig.) is 0,000, that is smaller than 0,05. This is supported by the results of the two-way ANOVA test on the final test results for mathematical reasoning abilities obtained $F = 74,69$ with the probability (sig.) is 0,000 that is smaller than 0,05, which shows the existence of different reasoning abilities between the experimental and control groups. In this case, the mathematical reasoning abilities of students who use MHM-PB are better than students who use conventional models. This means that the MHM-PB learning model affects students' mathematical reasoning abilities.

Furthermore, regardless of the learning model used, the final test results are obtained $F = 0,106$ with the probability (sig.) is 0,746, greater than 0,05. This means that male and female students have the same reasoning abilities. These results support the results of the test results in which increased reasoning abilities have obtained the value of $F = 0,27$ with the probability (sig.) is 0,61 that is greater than 0,05. This means that there is no difference in the increase in mathematical reasoning abilities between male and female students. Based on the results of further tests with the Scheffe test, the sig. value was obtained 0,976 greater than 0,05, so there is no difference in reasoning ability between male students and female students in the group of MHM-PB strategy.

The results show that the mathematical reasoning abilities of students who get MHM-PB are better than students who use the conventional model. This happens because of the

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various advantages of the MHM-PB model. Through the MHM-PB strategy, students are accustomed to constructing or making examples, exploring mathematical ideas, making generalizations, and solving mathematical problems. This is confirmed in NCTM (2000) that mathematical reasoning occurs when the learner: 1) observe a pattern, 2) formulate generalization and conjecture related to observed regularity, 3) assess/test the conjecture; 4) construct and assess mathematical arguments, and 5) describe (validate) logical conclusions about some ideas and its relatedness. This is also in line with the opinion of experts that reasoning works when someone tries to understand problems, make relationships and representations between concepts, as well as assumptions and generalizations, to prove these allegations (Napitupulu et al., 2016; Hasanah et al., 2019). Students' reasoning abilities are built when they are involved in the problem-solving process. Positive habits that are consistently carried out can develop positive abilities, with thinking habituation capable of spurring students to build reasoning ability (Mahmudi & Sumarmo, 2015).

Constructing examples as part of learning with MHM-PB has many benefits in improving students' reasoning abilities. According to Dreyfus et al. (2006) constructing examples is a complex task that requires students to make connections between concepts. Students may make incorrect generalizations if students are not allowed to construct examples and non-examples (Miliyawati, 2014). Making proper generalizations through MHM-PB indicates the students' good reasoning ability when allowed to make examples.

The habits of exploring mathematical ideas in learning with the MHM -PB strategy enable students to determine the relationship between various mathematical concepts. According to Miliyawati (2014), the MHM strategy promotes students to make connections between mathematical ideas, which is one of the advantages of MHM-PB compared to conventional learning.

Students' ability to collaborate to conduct exploration and challenges during the MHM-PB strategy promotes meaningful learning. The research obtained several attributes that promote meaningful mathematics learning, specifically to ensure: a) students are challenged and active, b) the teacher pays attention to the development of students' ideas, c) appropriate and open tasks, d) collaboration and e) there are good appreciation and acceptance of ideas, conjectures, and other alternatives given by students (Mueller et al., 2014). According to Mahmudi & Sumarmo (2015), student learning activities with problem-based MHM strategies provide opportunities for developing their actual and potential abilities following Vygotsky's theory. Furthermore, Yackel & Cobb (1996) stated that a learning community is formed where students learn actively, provide, respond and defend emerging ideas in a discussion. Mathematical reasoning and understanding naturally arise from communication in such communities.

In the MHM-PB strategy, the teacher acts as a facilitator to guide students during group discussions. When students do not understand a topic, the teacher does not give direct answers. Instead, they provide probing or guiding questions, such as asking them to explain their thinking, offer evidence, and use previous knowledge

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to deal with problems that arise. According to Mueller et al. (2014), probing questions provide a deeper conceptual understanding and enables students to connect previous knowledge with new ideas. Through guiding questions, the teacher tries to guide students in solving problems by asking for solutions, procedures, or strategies. Furthermore, it strengthens students' conceptual understanding and supports them in creating their heuristics (Mueller et al., 2014). Meanwhile, interactive media in learning with the MHM-PB strategy has various advantages, such as facilitating students' understanding (Nickchen & Mertsching, 2016). This is due to the strong relationship between students' understanding and reasoning (Bakar et al., 2018). Similarly, Hwang et al. (2015) stated that interactive media could develop students' mathematical abilities.

In conventional learning, the teacher provides concepts or materials directly to students and then draws questions with the solution, followed by exercises. In this strategy, they learn by paying attention to the teacher during the learning activities. Furthermore, they are not allowed to participate actively. Therefore, the learning atmosphere feels boring, and various cognitive aspects possessed by students are less developed, including mathematical reasoning.

The result showed that students that use the MHM-PB strategy are more active in exploring and solving problems presented on worksheets. Meanwhile, those with conventional learning are less involved in thinking activities to explore new ideas related to the studied concepts. The results of this research are in line with previous studies. For instance, Dwirahayu et al. (2018) stated that Habits of Mind

positively influence mathematical ability generalization. MHM strategy allows students to think logically, systematically, accurately, and critically (Hafni et al., 2019). This research is also in line with the previous studies carried out by Napitupulu et al. (2016), Siregar et al. (2017), Bernard & Chotimah (2018), Saleh et al. (2018), which uses constructivism-based learning to improve students' mathematical reasoning ability. The study successively uses Problem-based learning, MCREST strategy, an open-ended approach using VBA for Power Point, and RME.

Furthermore, without paying attention to the learning model, the results of this study indicate that there is no difference in mathematical reasoning abilities between male and female students. The results of this study are in line with the results of the study Salam & Salim (2020), which states that if you ignore the learning model, used mathematical reasoning abilities between male and female students do not differ significantly. Furthermore, the students who used the MHM PB strategy of male and female students' mathematical reasoning abilities did not differ significantly. This is in line with (Kadarisma et al., 2019) stated that is no significant difference in mathematical reasoning abilities between male and female students after using a problem-based learning approach. Thus, the MHM-PB Strategy can minimize differences in mathematical reasoning between male and female students.

In MHM-PB, discussions carried out to explore mathematical ideas or solve problems are carried out in small groups consisting of students with different abilities and genders. This can reduce the ability of male and female students to reason. The division of

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small heterogeneous learning groups is one factor that causes no difference in mathematical reasoning ability between men and women (Kadarisma et al., 2019). Small groups from diverse backgrounds can help overcome social barriers among students and allow collaborative learning among them (Argaw et al., 2017). In order to be active in group discussion and exercise independent learning, students need to develop social skills (Ulger, 2018).

Furthermore, the study determined several weaknesses possessed by most students, as indicated in their answers can be seen in the following description.

Problem 1

The properties of a triangle are known as follows:

- a. Has 2 equal sides.
- b. Has 2 angles of the same size.
- c. Has 1 axis of symmetry and 1 rotational symmetry.
- d. Occupy its frame in 2 ways.

From the above statement, we can conclude what the triangle is?

Examples of student answers can be seen in Figure 1.a and Figure 1.b.

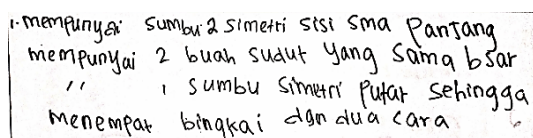


Figure 1.a. Examples of students' wrong answer

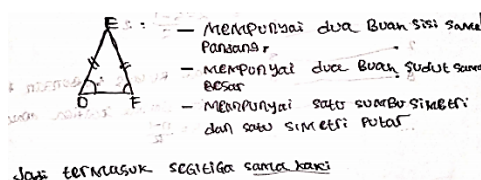


Figure 1.b. Examples of students' correct answer

In Figure 1.a, the student did not answer. He only wrote back the properties of the triangle that were written in the question. This shows that students have not understood the triangle concept well, so they are weak in reasoning and checking the truth.

To make it easier to solve these problems, one way to sketch an image based on the information provided. Making a written presentation of ideas into pictures will help students organize their thoughts, but they do not do it. This indicates that students have weaknesses in representing written ideas in the form of images that will help them answer Problem 1. According to Noto et al. (2016), the right of representation makes mathematical ideas more concrete, and complex problems become simpler so that they are easier to solve. Meanwhile, in Figure 1.b, the students concluded that the triangle that fulfills the characteristics described in the problem is isosceles. To make it easier to make conclusions, students sketch images from the data provided in the questions.

Problem 2

Are all equilateral triangles right triangles? Explain!

Example of student answer for Problem 2 can be seen in Figure 2.

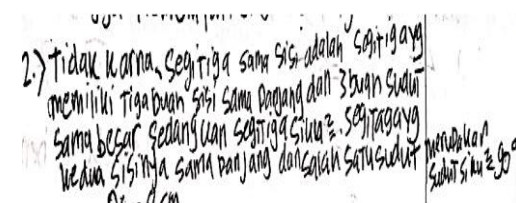


Figure 2. Examples of students' wrong answers

In the Figure 2, it appears that students are giving reasons for wrong answers. The student explains that a

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right triangle is a triangle whose sides are the same length, and one angle is a 90° right angle. From these answers, these students do not understand the concept of a right triangle. A triangle with both sides is the same length, and one of the angles measuring 90° as explained by the student, is an isosceles right triangle. Students do not understand that a right triangle should not have two sides of the same length. This means that students do not understand the types of triangles (equilateral, isosceles, and right triangle) as a whole and the relationship between these triangles. The lack of understanding of these students causes student errors in providing reasons for the answers given by students to the problems. According to Strand et al. (2006) lack of understanding of the basic concepts of a topic fails to use formal procedures to solve several types of problems and its differences based on gender.

Another example of students' answer in Problem 2 can be seen in Figure 3.

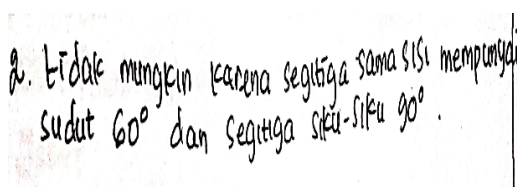


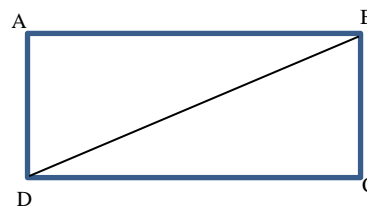
Figure 3. Examples of student answers

Students give correct answers, but the reasons given are not clear. According to the students, an equilateral triangle has an angle of 60° , and a right triangle is 90° . The answer is not clear whether all the angles are 60° or if one of the corners has a magnitude of 60° . If the triangle is only one of the corners that has a large 60° , then it is still possible that the other angles have a large 90° and 30° . Such a triangle is a right triangle. Thus, it appears that

students are less able to communicate their ideas in writing. This is in line with research Sumaji et al. (2019), students have problems communicating given problems, and students have problems communicating mathematical problems in the form of the written text

Problem 3

Given a rectangle.



DC length 8 cm and CB length 6 cm, then:

- BD length is 10 cm. Is that right? Prove it!
- The area of triangle BCD is 24 cm^2 . Is that right? Prove it.

From the results of the students' answers, some students answered incorrectly. Figure 4 is an example of a student's wrong answer.

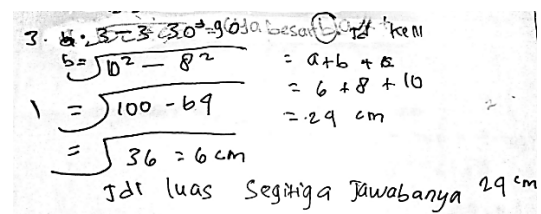


Figure 4. Examples of students' wrong answers










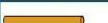


The student answered incorrectly to question Problem 3.b. The student determined the area by adding up the length of the sides of the triangle BCD. In other words, the student looks for the area using the concept of the perimeter of the triangle. From the calculation results obtained 24 cm, these results are considered by students as the area of the triangle. From this answer, it can be

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seen that students do not understand the rules for area and the rules for the perimeter of a triangle and the concept of units of length and units of area. The student does not understand that the 24 cm he gets from the calculation is the perimeter of the triangle, while the area of the triangle is $(6 \times 8) / 2 = 24 \text{ cm}^2$. The student's lack of understanding of these basic concepts causes student errors in solving problems. This is in line with (Strand et al., 2006). As previously explained, students' failure to solve problems is caused by a lack of understanding of the basic concepts

Problem 4

Given 4 sets of logs with the following length.

Set A	Set B
3 cm 	3 cm 
4 cm 	3 cm 
5 cm 	7 cm 
Set B	Set D
3 cm 	3 cm 
5 cm 	4 cm 
7 cm 	7 cm 

Can every set of logs form a triangle?
 Give reasons!

One of the examples of students' answers given by the majority is shown in Figure 5.

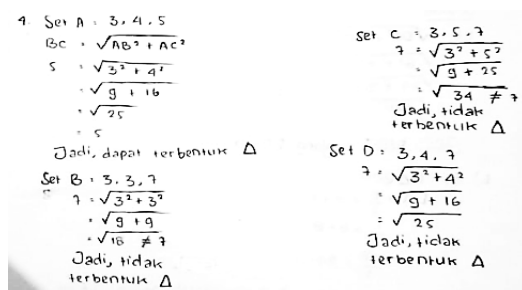


Figure 5. Example students' answer




Figure 5 shows that students did not give correct answers because they stated that triangles could not be formed

with side lengths of 3, 5, and 7 units (the length of one log represents, in this case, one unit). The conclusion is only based on checks made using the Pythagorean rule, which only applies to a right triangle. When a check is carried out using the triangle's properties, the length of wood 3, 5, and 7 units can be arranged. This is because the two sides' length is more than the other side and similar to the sets of logs whose lengths are 3, 3, and 7. In this case, students provided answers with the wrong reasons by using Pythagoras' rules, which did not link to the triangle's other properties.

Students' errors in solving Problem 4 show their weakness associated with a mathematical understanding of using the triangle rule and the Pythagorean formula. In other words, students' reasoning abilities are supported by mathematical understanding. This study's results align with (Bakar et al., 2018), research on the strong positive relationship of mathematical concept understanding and reasoning. Napitupulu et al. (2016) stated that students have difficulties constructing proof due to a lack of understanding of the materials that need to be applied. Most students with low reasoning abilities have weaknesses in providing examples in solving problems, compiling evidence, checking the validity of answers, and drawing conclusions (Hasanah et al., 2019).

Problem 5

Given several matchsticks are used to form equilateral triangles as in following table.

The number of matchsticks	3	5	7	9	...
The number of Triangles			

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Find the pattern of the relationship between the number of matchsticks and the number of equilateral triangles that can be formed!

Of the answers provided by students, only a few were correct and under the relationship pattern. Figure 6 shows an example of a student's wrong answer.

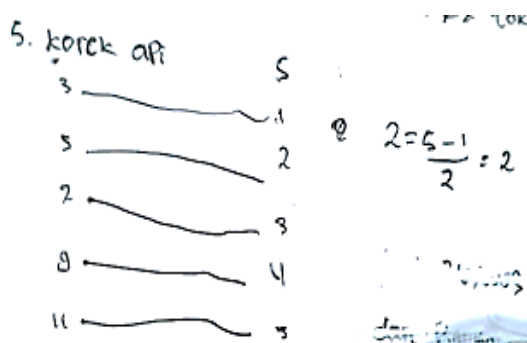


Figure 6. Examples of students' answers

Figure 6 shows that students already see the formation of several matches with triangles in the first pattern and failed to write other patterns of relationships. In this case, students still have difficulty determining the relationship pattern between triangles and matchsticks. This means that they are still finding it difficult to generalize. Napitupulu et al. (2016) stated that the mistakes and difficulties of students in answering the mathematical reasoning ability test are due to 1) misinterpretation or drawing illogical conclusions despite being aware of the assignment demands, 2) lack of metacognitive processes, 3) Unable to build meaningful relationships between the available facts and the objectives, 4) inability to build data-based or pattern-based conjectures, and 5) misconceptions of deductive and inductive thinking. Moguel et al. (2019) showed that mathematics teachers had difficulty observing regularity,

determining the patterns, and formulating generalizations.

Based on the research results, the MHM-PB strategy assisted by interactive multimedia, which is applied in mathematics learning, has a tremendous impact in helping develop students' mathematical reasoning abilities. These results can be a reference for teachers in developing mathematical reasoning skills, namely by applying the MHM-PB strategy assisted by interactive multimedia in learning mathematics. In addition, the findings of student errors in working on the reasoning ability questions on this triangle material indicate that the common understanding of concepts affects students' reasoning so that it can be used as material for evaluation and reflection, especially for junior high school mathematics teachers to emphasize understanding concepts in the learning carried out. The limitation of this research is the absence of computer equipment to support interactive multimedia in research. The interactive multimedia used based on Microsoft PowerPoint is only operated by researchers, not by students.

CONCLUSION AND SUGGESTION

In conclusion, students taught with mathematical habits of mind-problem-based strategy aided interactive multimedia learning to have better mathematical reasoning abilities than those with conventional learning. The mathematical reasoning abilities of male and female students using the MHM-PB strategy were not significantly different. Furthermore, some students still had difficulty making conclusions, providing reasons or answers to the questions they gave, and checking the correctness of statements. The difficulty that many

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students do is that it is difficult to see the regularities in the data given to determine patterns and formulations. The difficulty of these difficulties is caused by the weakness of students to represent written ideas in the form of images to help solve problems, the weak ability of students to understand basic concepts, the weak ability to determine linkages between concepts, the weak ability of students to communicate an idea.

The MHM-PB aid interactive media strategy can be used as a learning strategy to improve students' mathematical reasoning abilities due to its various advantages. In addition, MHM-PB can minimize differences in the reasoning abilities of male and female students. Therefore, research on the impact of using MHM PB aid interactive media on various mathematical thinking abilities needs to be conducted. Furthermore, it is necessary to research ways to overcome student difficulties in tests of mathematical reasoning abilities. In addition, due to the growing development of various IT-based learning media, further research is needed on the effectiveness of using interactive media as a tool for the MHM-PB strategy.

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