KnE Social Sciences
ICMScE
International Conference On Mathematics And Science Education
Volume 2024

Research Article

Students' Adaptive Reasoning in Solving Pythagoras Theorem Problems Viewed by Gender

Khaluka Ahsana Fitri*, Sufyani Prabawanto, Endang Cahya Mulyaning

Department of Mathematics Education, Universitas Pendidikan Indonesia, Dr. Setiabudhi Street No. 229, Bandung 40154, Indonesia

ORCID
Khaluka Ahsana Fitri.: https://orcid.org/00000-0002-6806-9560
Sufyani Prabawanto: https://orcid.org/0000-0003-2872-6535
Endang Cahya Mulyaning: https://orcid.org/0009-0009-8495-7873

Abstract.
Adaptive reasoning is one of the mathematical proficiency strands that refers to the capacity to reflect, explain, justify, and think logically about concepts and situations. It helps student construct their idea in solving mathematics problems. On the other hand, students' adaptive reasoning still needs to be developed. This is a qualitative study with a case study design. This study was carried out to analyze students' adaptive reasoning in solving Pythagoras Theorem problems based on gender. There were 31 student participants, of which 14 were males and 17 females. They were the second grade of senior high schools in South of Aceh. There were several steps involved in conducting this study, such as formulating and validating the problems, conducting the test, and interviewing. The problems were formulated based on the adaptive reasoning indicators and curriculum. They were then validated by two lecturers and a teacher. Furthermore, the test was carried out for 20 minutes for answering 4 problems. This study showed that female students were able to solve adaptive reasoning problems as compared to male students.

Keywords: adaptive reasoning, gender, solving pythagoras theorem problems.

Corresponding Author: Khaluka Ahsana Fitri; email: khalukaahsanaf@upi.edu

Published: 26 April 2024

Publishing services provided by Knowledge E

© Khaluka Ahsana Fitri et al. This article is distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use and redistribution provided that the original author and source are credited.

Selection and Peer-review under the responsibility of the ICMScE Conference Committee.

OPEN ACCESS

1. INTRODUCTION

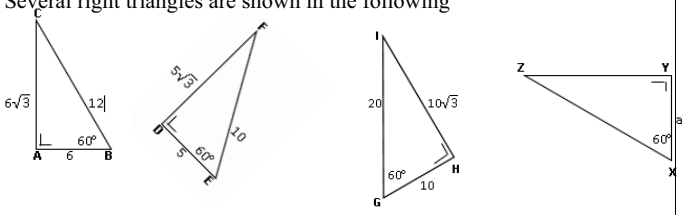
Mathematical proficiency is one of the crucial thing needed in mathematics education. It is constructed from five intertwined and interdependent strands; conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition [1]. It is cannot only focus on a strand or some of them, but it is developed by them all together. Furthermore, adaptive reasoning, one of mathematical proficiency strands, helps students to construct their own mind idea in solving mathematical problems [2, 3]. Not only as a crucial issue in mathematics education lately, but also students are expected to possess adaptive reasoning ability as one of mathematics education goals in Indonesia curriculum.

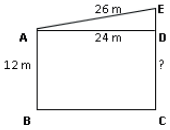
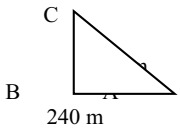
Adaptive reasoning refers to capacity for logical thought, reflection, explanation, and justification [1]. Then, logical thought means the ability to generalize the conjectures, meanwhile reflection refers to the ability to check the truth of mathematics procedure. Furthermore explanation means the ability to interpret the solution, and justification is the ability to state the reason on a statement or a solution in mathematics. in the other hand, adaptive reasoning known as a glue that connect all kind of reasoning and guide learning process [4]. Then, it not only involves justification and informal explanation, but also intuitive and inductive reasoning as a basic of pattern, analogy, and metaphor [1]. It is also a significant predictor of student mathematics achievement.

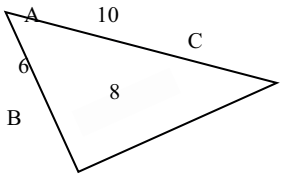
Several previous researches show that students' adaptive reasoning are still need to be developed. Student with low mathematical ability cannot construct their adaptive reasoning [5–7] meanwhile they whose high adaptive reasoning are only able to expand adaptive reasoning at medium level [5]. Then, student adaptive reasoning in solving rectangle problem was only in visualization level, the lowest van hiele level [7]. In the other hand, gender significantly predict student achievement in mathematics. Based on the previous problem, this study was carried out to analysis students' adaptive reasoning in solving Pythagoras Theorem viewed by gender.

2. RESEARCH METHOD

This is qualitative research with case study design. A case study is one of qualitative research design that explore processes, activities, and events in depth [8]. The purpose of this study was to analyse the students' adaptive reasoning in solving Pythagoras Theorem problems viewed by gender. There were implemented several steps to carry out this study, they are formulating and validating the problems, conducting the test, and interview. First, Four problems were tested to assess students adaptive reasoning. There are four indicators of adaptive reasoning and every problem assessed one of them. The problems are shown in Table 1. Then, the problems were validated by a mathematics teachers and two lecturers. Second, the test was held for 31 participants; 14 males and 17 females during 20 minutes. The participants were the second graders of junior high school in South of Aceh. Third, interviews were conducted for several six students based on their answer sheet during 15 minutes for each.

<table>
<tr><th>No</th><th>Problems</th><th>Indicator</th></tr>
<tr><td>1</td><td>Several right triangles are shown in the following
 

Find the comparison of the sides of the XYZ triangle!</td><td>Logical thought</td></tr>
<tr><td>2</td><td>Two poles stand side by side 24 m apart. If the height of the shortest pole is 22 m and the length of the connecting wire between the two ends of the pole is 26 m. then the length of the highest pole can be calculated in the following steps.
<table><tr><td>We can see the sketch of the story above.
 
</td><td>Using Pythagoras Theorem, we that
$DE^2 = 26^2 + 24^2$
$DE^2 = 676 + 576$
$DE^2 = 1252$
$DE = \xi\ \overline{1252}$
DE = 35,38
So, length of the highest pole is meter.</td></tr></table>Check wheter the previous steps in the table are correct or not, state your reason!</td><td>Reflection</td></tr>
<tr><td>3</td><td>Toni sit facing the pine tree. The distance between Toni and pine tree base is 240 meters, meanwhile the distance between Toni and the tip of the pine tree is 250 meters. The following sketch describe the situation above.
 

A is Toni position, B: the base of pine tree, and C is the tip of pine tree. If we solve using Pythagoras Theorem we find that BC=70 m. What is BC=70 m means?</td><td>Explanation</td></tr>
<tr><td>4</td><td>Look at the following right triangle!
 

Explain why the triangle above is a right triangle!</td><td>Justification</td></tr>
</table>

Figure 1: The problems for assessing adaptive reasoning.

3. RESULTS AND DISCUSSION

In this study we analysed student adaptive reasoning in solving Pythagoras Theorem problems. This study shows that more than half of the student cannot solve the problems well. Most of students did not write anything on the answer sheet. Based on the interview, S2 let the paper empty because he was not able to understand the problem given. Most of student get error in comprehension step in solving mathematical problem [9–11]. Furthermore, S2 also declared that he did not understand about the Pythagoras

Theorem well. He got some problems during the learning process. Students will able to develop their adaptive reasoning when the have sufficient prior knowledge, and vice versa [1]. Diagram 1 shows the percentage of the student adaptive reasoning in solving the problems based on the indicators.

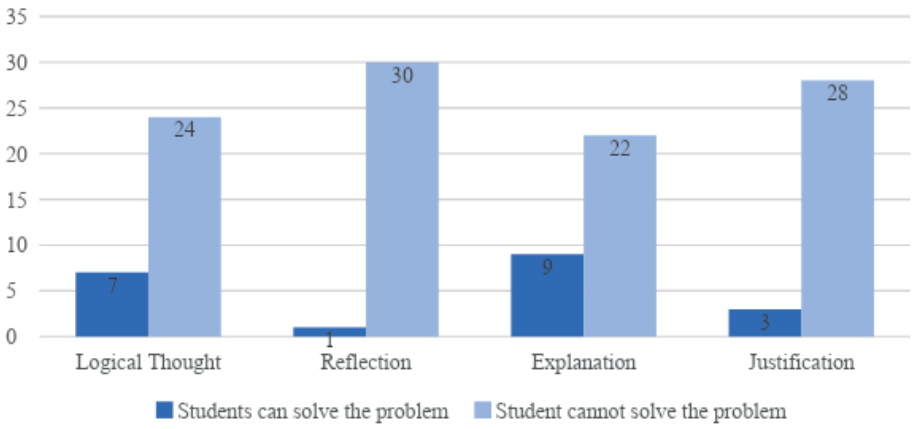


Figure 2: The summary of student adaptive reasoning.

Specifically, 14% of male and 29% of female students were able to solve logical thought problem. Then, there was an equal amount of students between males and females who were able to solve reflection problem, one for each gender. Furthermore, female students were still supreme in quantity than male for explanation and justification problems. Table 2. shows amount of students who were able to solve adaptive reasoning problems.

TABLE 1: Student adaptive reasoning viewed by gender.

	Males	**Females**
Logical Thought	14%	29%
Reflection	7%	5%
Explanation	7%	47%
Justification	7%	11%

Based on the interview, most of student answered the question by remembering the notes in their book in solving logical thought problem. They recall the algorithmic given in the text book and even ignored the clue given in the problems and wrote the answer based on their notes. This reasoning is a part of imitative reasoning called algorithmic reasoning. Algorithmic reasoning fulfil two conditions; the strategy choice is to recall a solution algorithm, the remaining reasoning parts of the strategy implementation are trivial [11]. On the other hand, there was a male student who answered the problem by identifying the similarities from previous example given in the problem. This kind of reasoning named identification of similarities. This reasoning satisfies two conditions;

1. The strategy choice is found on identifying similar surface properties in an example, theorem, rule, or some other situation described earlier in the text. 2. The strategy implementation is carried through by mimicking the procedure from the identified situation [12]. Figure ?? shows student answer sheet for logical thought problem.

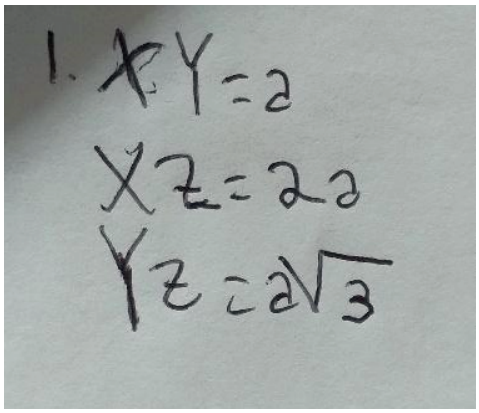


Figure 3: Student answer sheet for logical thought problem.

There were only two students who were able to solve reflection problem. Every of them were from each gender. Both of them answer this question by checking the correctness of the sketch given. In the sketch the found that AB is longer than DE, meanwhile Pythagoras Theorem result showed that DE is longer than AB. It was a contradiction. The length of DE is longer than AB. This way of validation is obtained by sensibility. Sensibility is a situation where the student tries to reassure that the answer is reasonable [13]. Figure 2 shows the student answer sheet in solving reflection problem.

All students answer the explanation question by understanding the information given. They solved the problem by following the instruction in the problem. Meanwhile all students answer the justification problem by remembering the theorem and the rule given in the text book. They used memorized reasoning in solving this problem. There are two categories of the memorized reasoning they are; first the strategy developed on complete answer remembered by rote, second the strategy built by writing every step that has been memorize before [14].

4. CONCLUSION

In this study we found that most of student cannot solve the adaptive reasoning problem. Most of them did not have the sufficient prior knowledge and cannot understand the problem well. Overall, female students tend to be able to solve adaptive reasoning problems than male. There were several types of the reasoning in solving adaptive

reasoning problem in this study; algorithmic reasoning, identification of similarities, and memorized reasoning. The limitation of this study is we only used a part of mathematics subject and only involved limited students. For future study we suggest to add more subjects and continue the research for all strands of mathematical proficiency.

Acknowledgments

I would like to express my gratitude to Indonesia Endowment Fund for Education for financial support and Universitas Pendidikan Indonesia do academic support.

References

[1] Kilpatrick J, Swafford J, Findell B. The strands of mathematical proficiency. Washington (DC): NATIONAL ACADEMY PRESS; 2001. p. 20418.

[2] Khusna AH, Yuwono I, Muksar M. “Pengembangan lembar kerja siswa (lks) berkarakteristik rme materi barisan dan deret untuk kelas x.,” Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan. vol. 1, no. 4, pp. 739–745, 2016.

[3] Literacy A, Lesgold AM, Welch-ross M. ”Improving adult literacy instruction options for practice and research”. 2012.

[4] Gusic M. “Investigating adaptive reasoning and strategic competence in Croatian mathematics education: the example of quadratic function.,” Towards new perspectives on mathematics education. p. 192, 2019.

[5] Ansari BI, Taufiq T, Saminan S. The use of creative problem solving model to develop students ’ adaptive reasoning ability: Inductive, deductive, and intuitive. International Journal on Teaching and Learning Mathematics. 2020;3(1):23–36.

[6] Mulyayunita A. “Analysis of students ’ adaptive reasoning in solving quadrilateral problem viewed by van hiele ’ s thinking level,” pp. 323–328, 2019.

[7] Recber S, Isiksal M, Koç Y. Investigating self-efficacy, anxiety, attitudes and mathematics achievement regarding gender and school type. Volume 34. Anales de Psicología/Annals of Psychology; 2018. pp. 41–51.

[8] Wijaya A, van den Heuvel-Panhuizen M, Doorman M, Robitzsch A. Difficulties in solving context-based PISA mathematics tasks: an analysis of students’ errors. Mont Math Enthus. 2014;11(3):555–84.

[9] Fitri KA, Jupri A. “Students’ errors in solving the connection cluster problem: a case study on space and shape content,” In: Journal of Physics: Conference Series. pp. 12079. IOP Publishing (2021). https://doi.org/10.1088/1742-6596/1806/1/012079.

[10] Riastuti N, Mardiyana M, Pramudya I. “Students errors in geometry viewed from spatial intelligence.” Journal of Physics: Conference Series. vol. 895, no. 1, p. 2017. https://doi.org/10.1088/1742-6596/895/1/012029.

[11] Lithner J. A research framework for creative and imitative reasoning. Educ Stud Math. 2008;67(3):255–76.

[12] Lithner J. Students’ mathematical reasoning in university textbook exercises. Educ Stud Math. 2003;52(1):29–55.

[13] Prabawanto S. “Students’ validations on their solution in mathematical problem solving,.” Journal of Physics: Conference Series. vol. 1157, no. 4, p. 2019. https://doi.org/10.1088/1742-6596/1157/4/042111.

[14] Herman T. Analysis of students’ mathematical reasoning. Journal of Physics: Conference Series. IOP Publishing; 2018.