REPRESENTATION OF SCHEMATIC VISUAL IN SOLVING PYTHAGORAS' WORDPROBLEMS

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Abstract
The aim of this article is to identify the steps which were done by the students in solving Pythagoras' word problems. This study used qualitative research by using explorative descriptive approach. The subject of this study was four students who werein seventh grade of Junior High school of Muhammadiyah 1 Jember. The subjects givenone problem in the form of story that had to be done based on their styles. From the result analysis of the study was found that the students tried to understand the aim of the problems by using picture, compass direction, and Pythagoras' pattern. In solving Pythagoras' word problem, the students used representation of schematic visual. In making schematic picture, the students were supposedto be consistent with compass direction. The student that isconsistent with compass direction can make the schematic picture correctly and with a picture,the student can solve the word problems by using Pythagoras' pattern correctly. The student who is inconsistent with compass direction will get difficulties in making schematic picture and not be able to solve Pythagoras' word problems correctly.

Keywords: Representation of visual schematic, compass direction, word problems, Pythagoras

Representation is expressing mathematical ideas from a problem aspect which used to solve the problems. (NCTM, 2000) stated that the expected standard representation can be mastered by the students during learning activities at school are: (1) making and using representation to know, make a note or record, and communicate mathematical ideas; (2) choosing, applying, and doing translation between mathematical representation to solve the problem; (3) using representation for modeling and interpreting physical phenomena, social, and mathematical phenomena. When the students are faced a mathematical problems in learning in the class, they will try to understand those problems and solve them in ways they know well. The ways are much concerned to background knowledg that related to the problems are served. One of parts from efforts done by the students is by making a model or representing from those problems. Model or representation made in any various depends on each student's ability in interpreting the problem.

The research about representation to solve the problems have been done by many researchers, they are (Delice & Sevimli, 2010; Santos-trigo, 2017; Surya, Sabandar, Kusumah, & Darhim, 2013; Suryaningrum, 2017). Delice & Sevimli(2010) showed that representation was most often used by the perspective teachers for the correct answer was algebra's representation in the process of solving problems (18.7%) and numerical representation (2.8%). While for the wrong answer, the representation used was algebra's representation (13.1%) and mixed-representation (1.6%). Utilizing mixed-representation ofwrong answerwas 7% for all. Santos-trigo (2017) stated that when the students asked to do the task by using different representation, when the students asked to determine the area and circumferencesof square. Students can complete the table based on side, area and

circumferences from any square so that they can determine pattern to find that. When connecting the graphic representation, algebra and numeric. The students construct the graphic; determine the area and circumferences which are correspondence with a square, give strong explanation among them. Surya et al. (2013) stated that from descriptive analysis result showed that the students with high ability taught using CTL, visual representation improved from 24.93 (pre-test) to 45.86 (post-test). It also occurred to the students taughtusing conventional learning, visual representation improved from 21.44 (pre-test) to 31.22 (post-test). The students with medium abilittaughtusing CTL, visual representation improved from 18.37 (pre-test) to 36.43 (post-test). It also happened to the students taughtusing conventional learning, visual representation improved from 16.62 (pre-test) to 25.23 (post-test). While for the students with low ability who taught using CTL, visual representation also improved from 12.0 (pre-test) to 26.31 (post-test). It also happened to the students taught using conventional learning, visual representation improved from 16.94 (pre-test) to 23.94 (post-test).(Suryaningrum, 2017) said that most of the students solved the word problems using two representations namely verbal and algebra representations and visual and algebra representations.

From the researches above showed that to solve a problem and understand mathematical concepts, the students can use visual representation. Visual representation is a strategy to display and think about mathematical information. Students are able to solve visual representation by expressing their mathematical ideas in the form of diagram, graphic or table, and picture. There are some indicators of visual representation that have to be understood by the students to make a very good visual representation, among others (1) reserve data or information from a representation to diagram representation, graphic or table (2) use visual representation to solve the problem (3) make picture of geometry's pattern (4) make picture of geometry form to explain the problem and facilitate the solving.

As a part of process mathematical problem solution, visual representation are divided into two are visual pictorial representation and schematic representation. It is suitable with Hegarty & Kozhevnikov (1999)who claimed that there are twotypes of representations in solving mathematical problem in the form of word, they were (a) pictorial representation, displayed the object visually which was explained in detail about the mathematical problem that was irrelevant with the solution. In pictorial representation, the students only identified things or people that mentioned in the problem (b) schematic representation, displayed in accordance withspatial relation from the problem text and included relevant spatial relation to solve the problem. Schematic representation is categorized as one of process mathematical problem solution in which the students reference spatial relation between object and person of the problem.

The research about visual schematic representation done by van Garderen & Montague(2003) and Kribbs, Rogowsky, Kribbs, & Rogowsky(2016). The result study of van Garderen & Montague, (2003) stated that schematic representation was positive correlated significantly in solving problem ability. The same study was also found at 30% successful degree while using picture representation,

the researchers also established 76% of total correct solution on MPI which was connecting to visual schematic representation (p.250). Thefindingsupported the use of schematic visual representation to improve the word problem solution ability. Kribbs et al. (2016) stated that schematic visual representation helps the children to find the correct solution as compared to use picture representation. But there is no guarantee that schematic diagram can improve mathematical ability for disable students for learning. The indications that disable students have emphasizing on drawing diagram from the data.

In this research, represntation of schematic visual is a strategy to present and solve mathematical problems by expressing mathimatical ideas in the form of diagrams, graphs or tables, and pictures. The indicators of representation of schematic visual are (1) redisplay the data or information from a representation to a picture, diagram, graph or table representation, (2) use visual representation to solve problems, (3) draw a picture, diagram, graph or table that is consistent with a scheme, (4) solve problems based on schematic pictures.

Based on the explanations above, this article will discuss about the result study which will be done by Junior High School students in solving the word problem about Pythagoras. This study is done to see the steps in detail that are done by the students in solving the word problem about Pythagoras.There are two steps of solving word problem, namely (1) representation step. In this step, students identify the information of the problem and represent the information into other forms of representation, (2) solving problem step. In this step, students plan and apply the plan to solve the problem using mathematical computation (Boonen, Van Wesel, Jolles, & Van der Schoot, 2014; Jitendra, George, Sood, & Price, 2010; Krawec, 2014)

METHOD

This research used qualitative research by using explorative descriptive approach. The subjects of this study were four students of the seventh grade of Junior High school of Muhammadiyah 1 Jember. The instruments that used in this research consisted of the researcher itself as the main instrument and auxiliary instrument was assignment about Pythagoras and interview. The subjectswere given a question in the form of word problem that was donebased on their styles.Word problem given to the subjects aimed to improve students' computating quality. It is supported by the idea of Boonen et al. (2014); Jitendra et al., (2010); Kribbs et al., (2016) that say successful word problem solving can lead to increased quality of computation skills in middle school students.

The data in this research are in the form of data from the students who do the word problem about Pythagoras and interview. The data which have collected are analyzed by using technique of qualitative analysis. Generally, the process analyzing data in qualitative research covers: data reduction, data categorization, synthesize, and work-hypothesis composition (Creswell, 2012).

RESULT AND DISCUSSION

In this research, the questions are given in the form of word problem. In finishing, the questions,the students had to be consistent in following compass direction. The following question is given to the students:

"Ina will go to the book store. To reach the bookstore, Ina usually walks three blocks to the east and four blocks to the north. Ina can take a shortcut through Narrow Street. What is the shortest way from Ina's house to the bookstore? (The problem was adopted from (Kribbs et al., 2016))

The result analyses from the subjects' answer were found various answers. The subject tried to understand the aim of the question by using picture, compass direction, and use Pythagoras' pattern. The following subject 1's answer when solved Pythagoras' word problem
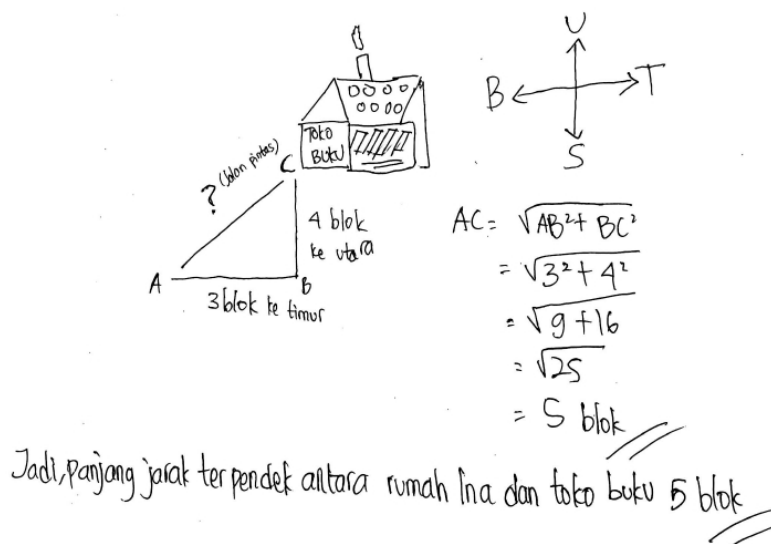

Figure 1. The Result of Subject 1

From the answer , subject 1 drew a picture to present the information of the problem. Visual representation of subject 1 was a picture. The subject drew a compass to make representation of schematic visual. After drawing a picture that was consistent with the compass, subject 1 computed the shortest way from Ina's house to the bookstore by using phytagoras' theorem formula so that he found that the shortest way from Ina's house to the bookstore is 5 blocks

The interview result between the researcher and subject 1 as follow:

P: How do you do the problem?
S: I read the problem thoroughly
P: to solve the problem, what are you doing?
S: I make the compas direction
P: What is the compas direction?
S: to make it easy for me to make a picture
P: Why do you make a picture?

S: to help me solve the problem
P: How do you solve the problem?
S: using Pythagoras formula

The interview result between the researcher and subject 1 was subject read the question carefully in the first step, then made compass direction and made sketching-picture of Ina's house to the book store through the Narrow Street. The subject looked for the length shortest distance Ina's house through the Narrow Street by using Pythagoras' pattern. From subject 1's answer above, it could be seen through doing the question the student made sketching-picture for the first time and followed the compass direction consistently madebeside the picture. The subject 1's consistency toward compass direction could help the subject 1 in making sketching-picture schematically and understand the aim's question easily. After understanding the aim's question, subject 1 solved the question by using Pythagoras' pattern. From subject 1's answer could be seen that by schematic picture subject 1 could be solved the question correctly. It differed from next subject 2's answer.
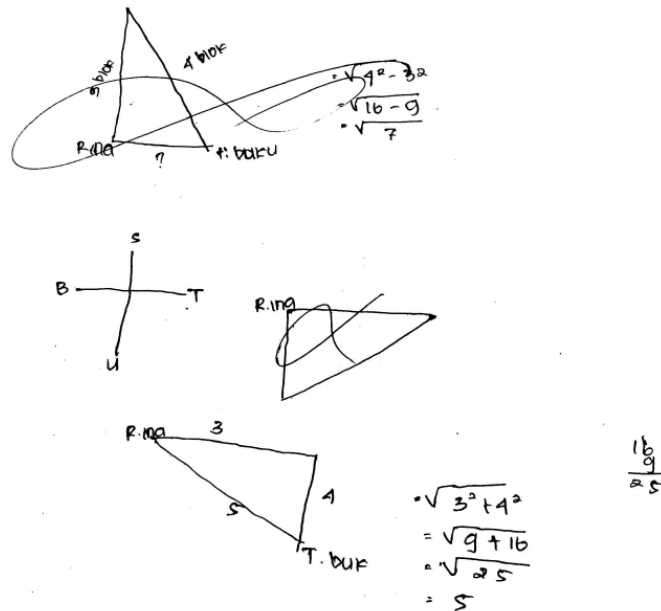

Figure 2. The Result of Subject 2

From the work of subject 2, subject 2 drew pictures three times. First, subject 2 presented the problem to a picture that was not schematic and did not solve the problem correctly. As a result, Subject 2 crossed the first answer. In order to present schematic visual, subject 2 drew a picture a compass. Even though the direction of the compass was inconsistent with the real direction, it helped subject 2 to make schematic visual. In drawing the second picture, subject 2 was inconsistent with the compass, so that the picture made was not schematic. Considering that the picture was not schematic, subject 2 tried to draw a picture that was consistent with the compass. Finally, the picture was appropriate with the scheme of the problem (the picture had already been schematic). With a

schematic picture, subject 2 solved the problem using Pythagoras' theorem and got the answer, that was 5.

Subject 2' answer above was very interesting; the researcher did an interview intensively to the subject 2, the interview result between the researcher and the subject 2 as follow:

R: what did you do after getting Pythagoras word problem?
S: I tried understanding the question
R: how did you understand the question?
S: I understood the question by reading the question many times
R: after reading the question many times, what did you do?
S: I solved the problem by making picture
P: what kind of picture did you make?
S: in the beginning I drew randomly, but I was confused with the answer that I got
P: then, what did you do?
S: I read the question again and made compass direction, and then I made a picture again. After I analyzed, the picture was not suitable with the compass direction. So, I made a picture again which was suitable with the compass direction. Then, I answered the question by using a pattern and got the answer was 5.

In the beginning of problem solving, subject 2 made compass direction, but answered the question directly.after answering done, subject 2 felt the answer was not suitable. Finally, subject 2 tried solving the problem by making his compass direction style. After making the compass direction, subject 2 made sketching-picture to help in solving it. In this case, subject 2 was inconsistent to compass direction that had been made by him, subject 2 unrealized the importance of compass direction he made. After subject 2 realized that his sketching-picture was not suitable with compass direction, subject 2 tried to make sketching-picture that followed compass direction he made, so it produced a picture schematically. Witha schematic picture, subject 2 solvedthe problemusing Pythagoras' pattern and produced the correct answer.

In solving the problem, there was a subject who was inconsistent to compass direction he made. Finally, the subject did not makea schematic picture. The following subject 3's answer by using picture which was not schematic.
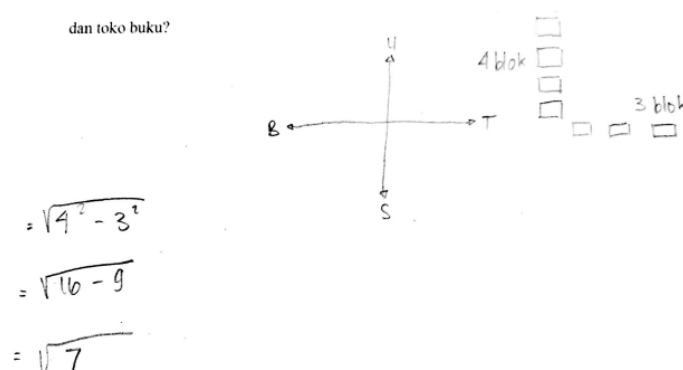

Figure 3. The Result of Subject 3

The answer of subject 3 showed that subject 3 presented the problem into a picture. In the beginning, subject 3 drew a compass that he used as a reference in drawing a schematic visual. Since subject 3 was inconsistent with the direction of the compass, the picture was not schematic. Subject 3 tried to solve the problem using Pythagoras' formula. As long as the picture was not schematic, subject 3 was not able to solve the problem correctly.

The interview result between the researcher and subject 3 as follow:

P: How do you do the problem?
S: I make the compas direction
P: What is the compas direction?
S: to help me in making the picture, because in the matter of Ina way 3 block to the east and 4 blocks to the north
P: Are the drawings you have made in the compas direction
S: (think) not
P: Why?
S: I am not careful
P: What about your answer?
S: My answer does not match what the question asked

The interview result between the researcher and subject 3 was gotten that in solving the problem, subject 3 read the question and made compass direction. But in making sketching-picture, subject 3 was not able to utilize compass direction that had been made by her. Subject 3 tried to solve the problem by using Pythagoras' pattern, but because the subject 3 did not understand the aim's question, so the subject could not solve it correctly. Subject 3's answer above, the student did not utilize compass direction to draw the travel route which was aimed in that question. Subject 3 unrealized the importance of compass direction to make schematic picture that helped subject 3 later in solving the problem. In solving it, subject 3 made picture 3 blocks and 4 blocks, but the direction was not suitable with the compass direction that he/she had madebefore. The picture madeby subject 3 showed that it was not schematic, so that it did nothelp subject 3 in solving the problem. Finally, subject 3 did notanswer the question correctly.

Compass direction is important in helping the student makes schematic picture. Without using compass direction, the student will do mistake in making schematic picture that is aimed in problem. Subject 4's answer that did not use compass direction in solving the problem was as follow.

Figure 4. The Result of Subject 4

The answer of subject 4 showed that subject 4 presented the information of the problem in the form of picture. However, the picture was not schematic. It happened because subject 4 did not draw the direction of the compass before he drew a picture. Subject 4 tried to solve the problem using Pythagoras' formula, but the result was incorrect.

The interview result between the researcher and subject 4 as follow:

P: How do you do the problem?
S: after reading the problem I made the picture
P: What picture do you make?
S: triangle
P: Why do you make a triangle?
S: because in the matter, the route of Ina path forms a triangle
P: does the drawing make you look at the way of Ina?
S: no, I just draw it
P: look at your answer. Do you think it's true?
S: yes, right

The interview result between the researcher and subject 4 was identified that subject 4 did not understand with compass direction. Subject 4 did not pay attention the route that was intended in question.From the student's answer result, it was seendirectly made triangle picture that was aimed to help in solving the problem. Subject 4 drew simply and wrote the length size that was appropriate to the numbers which were in a question. Subject 4 was not able to answer the question correctly, because the picture was not appropriate with the aim's question. Picture that had been made by the student could not help him in understanding the aim's question. Subject 4 did error in using Pythagoras' pattern, so subject 4 could not answer the question correctly.

DISCUSSION

From the answers of the four subjects of the research, all the four subjects represented the information of the problem into pictures. Subject 1 drew schematic picture, while subject 2 drew did not draw schematic picture in the beginning. He attempted to draw a schematic picture by revising his picture twice. Finally, he drew schematic picture. Subject 3 and 4 drew non schematic (pictorial) pictures. In solving the problem, all the four subjects used Pythagoras' formula. Subject 1 and 2 could solve the problem correctly because subject 1 and 2 used schematic pictures. The results was in line with the results of the researches (Kribbs et al., 2016; van Garderen & Montague, 2003) that said schematic representation significantly correlates positively with the ability of solving problem. On the other hand, subject 3 and 4 could not solve the problem correctly because they drew non schematic (pictorial) pictures. The results supported by the ideas Blatto-Vallee, Kelly, Gaustad, Porter, & Fonzi, (2007); van Garderen & Montague(2003)who said that representation of pictures significantly correlates negatively with the work of problem solving.

Schematic picture is for helping the students in solving the word problem about Pythagoras. This is suitable with the result study of Kribbs et al. (2016) stated that schematic picture could help

the students to find the shortest route by using Pythagoras' pattern. The students who made non-schematic (pictorial) picture were not able to answer the word problem correctly. The finding in this study was for making schematic picture that the students had to be consistent with compass direction.

CONCLUSION

Form the data analysis, the four subjects of the research presented the information of the problem using pictures. In order to draw a picture, the subject has to draw the direction of the compass. To be able to make schematic picture, the students must be consistent with compass direction. Schematic picture can help the students in solving the word problem.Of the four subjects of the research, there were only two subjects drawing schematic pictures because the two subjects were consistent with the direaction of the compass they made.In solving the problem, the four subjects used Pythagoras' formula. The subjects who were consistent with compass direction were able to make schematic picture and by those helping picture the students were able to solve the word problem by using Pythagoras' pattern correctly. The subjects who were not consistent with compass direction would get difficulties in making schematic picture and were not able to solve Pythagoras' word problem correctly.Of the four subjects of the research, only two subjects found the shortest way from Ina's house to the bookstore.From this results' study, it is needed advance research about the advantage of compass direction learning in answering the question and representation of schematic visual if the problem is served in the form of semiotic.

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