PISA Problems Solving of Students with a Visual Learning Styles

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Abstract. Mathematics’ problem on PISA measures students’ ability of reasoning, problem solving and argument. So far, students are not well trained in solving PISA problems. Therefore it is necessary to know the ability to solve mathematical problems to be taken into consideration in providing questions that are similar to PISA questions. This study aims to describe students’ ability to solve mathematical problems oriented to PISA on space and shape content. This type of research is a qualitative descriptive study. The subjects of this study were students who have visual learning styles. The instruments in this study involves PISA mathematics question about space and shape content and student learning style questionnaires. The data analysis techniques used were data reduction, data presentation, and conclusion. In obtaining data validity, researchers used sources triangulation. The results of this study show that students with a visual learning style understand the problem systematically and clearly by determining the known and unknown of the data. At devising a plan phase, students could find the connection of the given diagram and they have constant character. At the carrying out the plan, students solve the problem coherently. At the looking back phase, students did not recheck every steps on problem solving as they confident with their answer.

Keywords: PISA, Problem solving, Visual learning style

1. Introduction
The Program for International Student Assessment (PISA) is a program organized by the Organization for Economic Cooperation and Development (OECD) regarding international student assessments [1]. The aim of PISA is to test 15 years-old students from all over the world in reading, mathematics, science and finance. In the PISA study, the content is defined as the material or content or mathematics subject that is learned in school. There are four materials tested in the content component, namely change and relationship, space and shape, quantity, and uncertainty and data [2].

The achievement of Indonesian students on PISA scores showed a significant increase of 22.1 points in 2015. Based on the average score, in mathematics competence there was an increase from 375 points
in 2012 to 386 points in 2015. However, in 2000 to 2015 Indonesia was rank in the lowest seven of several countries participating in PISA. Indonesia placed 39 out of 41 countries in 2000, 38 out of 40 countries in 2003, 50 out of 57 countries in 2006, 61 out of 65 countries in 2009, 64 out of 65 countries in 2012, and position 63 out of 69 countries in 2015. Lastly, the result of PISA 2018, Indonesian students’ achievement was on 74th of 79th countries [3]. In particular, the average students’ achievement on mathematics was 379 lower than overall average 489 [4]. PISA concern for the mathematical literacy that is judged to be valuable to 15-year-olds for their lives [5]. From these results, it shows that the mathematical literacy skills possessed by Indonesian students are still in the low category.

The low ability of students' mathematical literacy is due to the lack of basic mathematical abilities of students, one of which is that students are less able to understand word-problem and have not been able to construct them into a mathematical model [6]. When students are asked to solve problem about the application of mathematics in everyday life, the ability of students to solve these problems is very weak as the learning process in the curriculum only leads to reading, writing and numeracy skills [6]. The cause that weakness is that students are less trained in solving problems with characteristics such as PISA test [7].

Based on the results analysis of Junior High School national exam 2018/2019 in the mathematics exam, the percentage of absorption capacity related to number material was 54.38%, while at algebra material was 65.01%, at geometry and measurement material was 55.13%, and statistical and probability material was 70.27%. This absorption capacity showed the students’ understanding and the quality of learning in national level. Based on these results, the absorption of geometry and measurement material was lower than that of algebra, and statistics material. It showed that students' understanding of geometry and measurement material was not good enough. Hence, it can be used space and shape context on PISA test to identify students’ understanding on geometry content.

Students’ abilities in solving mathematics problem were various and different each other. Some research showed that problem solving abilities were influenced by students’ learning style and learning style of students had positive impact toward their achievement [8]–[12]. In mathematics problem solving, the student's learning style visual, auditory, and kinesthetic also both have different patterns in solving a mathematical problem solving with Polya steps [8]. Based on this research, it was found that each different learning style has different problem-solving abilities. Learning styles are a unique way of learning that each individual has in the learning process, namely selecting, receiving, absorbing, storing, processing, and processing information [13]. In learning styles, there are three modalities, namely visual, auditory and kinesthetic [14]. Every student has access to all three modalities, it's just that every student tends to one learning modality, so that students' ability to absorb and process information in learning is different. As the Geometry Standard takes a broader view of the power of geometry by calling on students to analyze characteristics of geometric shapes and make mathematical arguments about the geometric relationship, as well as to use visualization [15] and also visual learners learn better what they see as figures, maps, diagrams, films, and flowcharts [16], thus this study focused on students with visual learning style. It was expected that students could optimize their problems solving abilities.

There have been some studies conducted toward PISA problem solving of students [17]–[22]. The research found that students can fulfill the indicator of problem solving quite well, however, there are some challenges on contextual problem-solving test, namely difficulties, unfinished answer, as well mistakes. Besides, some research conducted about learning style [23]–[28] show that there was positive relationship between learning style and problem solving and it will influence how they can manage their learning to improve their academic achievement. There is, however, no specific study conducted about PISA problem solving on visual learning style students as the research focused on geometry content. Based on the explanation above, this study aims to describe students’ ability on solving mathematical problems oriented to PISA space and shape content of students with visual learning styles.
2. Research Method
This research type was qualitative description. The subject was Junior High School students in Surakarta that categorized as visual learning style. The questionnaire was used to classify student learning styles. Meanwhile, the main data was collected by test to identify students’ ability on solving PISA problems. The test was adopted on PISA test 2012 that modified in Indonesian culture. The data was analyzed by data reduction, presentation, and conclusion. Moreover, the data was validated by sources triangulation.

The problems solving ability of students were analyzed based on Polya phases. There are four main phases on solving the problems, namely understanding the problem, devising a plan, carrying out the plan, and looking back [29]. The indicator of each phases is presented in Table 1 as follows.

| Phases                  | Explanation of the Indicators                                                                 |
|-------------------------|-----------------------------------------------------------------------------------------------|
| Understanding the problem| You have to understand the problem. What is the unknown? What are the data? What is the condition? Is it possible to satisfy the condition? Is the condition sufficient to determine the unknown? Or is it insufficient? Or redundant? Or contradictory? Draw a figure. Introduce suitable notation. Separate the various parts of the condition. Can you write them down? |
| Devising a plan          | Find the connection between the data and the unknown. You may be obliged to consider auxiliary problems if an immediate connection cannot be found. You should obtain eventually a plan of the solution |
| Carrying out the plan    | Carrying out your plan of the solution, check each step. Can you see clearly that the step is correct? Can you prove that it is correct? |
| Looking back             | Examine the solution obtained. Can you check the result? Can you check the argument? Can you derive the result differently? Can you see it at a glance? Can you use the result, or the method, for some other problem? |

3. Result and Discussion
Based on the learning style questionnaire result that given to a class of students, there are 30.34% of students with visual learning style, while 47.83% and 21.74% of students are auditory and kinesthetic learning style respectively. It was chosen two subjects with visual learning style to be identified the problems solving abilities.

3.1. Understanding the problem

On the understanding problem, subject S1 identified the problem by writing down information that is known but has not been able to write down the information asked about the problem given. From the results of the interview, the subject has not been able to retell the problem completely. Subjects need
other people's explanations to help understand the existing problems. The subject also explained that pictures and recorded explanations from others can help to understand a problem.

![Figure 2. Understand the problem stage of Subject S2](image)

Based on the results of the work of the subject S2 in writing, at this stage the subject has written down the information that is known and what is being asked about the problem. However, there is some information that the subject did not write down. Based on the results of the interview, the subject has not been able to tell the problem completely. The information asked in the questions has not been fully explained. To understand the problems that exist, the subject needs an explanation from others. The subject also explains that pictures and notes other people's explanations can help to understand the existing problem.

In understanding students' problems with visual learning styles, other people need explanations and then write them down. In addition, students with a visual learning style understand the problem through an image. Based on their characteristics, students with visual learning styles tend to find it easier to capture and process information with visual associations. This result matched with other studies, whereas students are also able to jot down the steps systematically and clearly and they tend to think by using systematic illustrations [30], [31].

### 3.2. Devising a plan

![Figure 3. Devise a plan stage of Subject S1](image)

Subject S1 in writing at the stage of compiling an article, the subject does not write down the strategies used to solve the problems in the question. From the results of the interviews that have been conducted, the subject of S1 is able to explain the strategies designed to solve the problem, but the subject has not been able to predict the problems solving strategy correctly. This can be seen from the incomplete strategy prepared by the subject and the subject cannot write it down on the answer sheet.

![Figure 4. Devise a plan stage of Subject S2](image)
Based on the results of the work of the subject S2 in writing, at this stage the subject does not write down the strategies used to solve the problems in the problem. From the results of the interview, the subject was able to explain the strategies developed to solve the problem, but the strategies compiled by the subject were not complete. The subject also cannot write down his strategy on the answer sheet.

In general, at the stage of preparing a plan, students with a visual learning style are able to explain the strategies to be used, but do not write the strategies on the answer sheet. This is in accordance with the characteristics of students with visual learning styles, namely they tend to know what to say. This is in accordance with the characteristics of the visual learning style proposed which is often knowing what to say [14]. Besides, students with visual learning style have constant characteristics when making a problem solving [30].

3.3. Carrying out the plan

![Figure 5](image_url)

Figure 5. Carry out the plan stage of Subject S1

Subject S1 has not been able to implement the right strategy to solve problems. The strategy prepared by the subject is incomplete, resulting in incomplete subject work. Based on the subject's written answer at this stage, the counting operation carried out by the subject is correct, but the subject is not precise in measuring the length of the side of the plan. Based on the results of the interview, the subject had no difficulty in performing arithmetic operations. So that the calculation operation performed by the subject is correct.

![Figure 6](image_url)

Figure 6. Carry out the plan stage of Subject S2

At this stage the S2 subject has not been able to carry out the strategy he has compiled to solve the problem. The strategy prepared by the subject is incomplete, resulting in incomplete subject work. The calculation operation carried out by the subject is correct, but the subject is not careful in measuring the length of the side of the plan. Based on the results of the interview, in implementing the subject plan did
not find it difficult. However, because the strategy prepared by the subject is still incomplete, the result of the subject's work is also incomplete.

At the stage of implementing the plan, subject S1 and subject S2 have not been able to carry out the plan completely. In question number 1, subject S1 and subject S2 have not been able to answer all the problems given. This is because the subject is not thorough in reading the questions, resulting in incomplete plans prepared by the subject. This is not in accordance with the characteristics of the visual learning style proposed, being careful with details [14]. However, the calculation operation performed by the subject is correct. In question number 2, subject S1 was able to carry out the strategy that had been compiled. However, subject S1 could not operate the calculation contained in the problem, this was also experienced by subject S2. However, in contrast to subject S1 who is able to carry out its strategy, subject S2 cannot carry out its strategy to solve problems. Subject S2 cannot determine the formula used to solve the problem in question number 2. In question number 3, subject S1 and subject S2 cannot determine the final answer to the problem given. However, both subjects were able to carry out their strategies appropriately and the calculation operations carried out were correct.

In general, students with visual learning styles have not been able to carry out the plans they have drawn up to solve problems. There are still errors in operation and it is still not complete in answering all the problems given. Based on their characteristics, students with visual learning styles sometimes lose concentration, so that they are still not right in implementing the plan. However, student with visual learning style is very good on solving the problems that integrated picture. It is in line with other research, visual students think in pictures and learn best in visual images [32].

3.4. Looking back

At the stage of checking back answers, the subject does not meet the indicators at this stage. This can be seen from the subject's answer, the subject only writes the final result of the floor area of the apartment. Based on the results of the interview, the subject did not re-check every step and calculation that had been done. The subject does not understand the meaning of the stage of checking back answers.

![Figure 7. Look back stage of Subject S2](image-url)

At the stage of checking back answers, subject S2 rewrote the answers at the stage of implementing the plan. Based on the results of the interview, the subject has rechecked the answers by recalculating the answers. However, the subject does not re-read the existing problems, resulting in the subject's work is still incomplete.

At the rechecking stage, the subject S1 did not double-check at each step because the subject did not understand the meaning of the rechecking stage. On the answer sheet subject S1 only write down the same answers as the stage of implementing the plan. At this stage, the S2 subject performs a rechecking stage, but what the subject does is only recalculate the answers that have been obtained without re-checking at each step. So that there are still some of the work of the S2 subject that is not right. In general, students with a visual learning style have not rechecked every step that has been done. This is in line with the research concluding that students with a visual learning style only work according to the plan that they have planned without double-checking the steps that have been taken [33].

In general, students with a visual learning style at the stage of understanding the problem are able to write down and retell the problems given, but are still incomplete. In understanding a problem, students with a visual learning style need other people's explanations and then write them down. In addition, students with a visual learning style understand the problem through an image. Based on their characteristics, students with visual learning styles tend to find it easier to capture and process information with visual associations. At the stage of preparing a plan, students with a visual learning
style are able to explain the strategies to be used, but do not write the strategies on the answer sheet. This is in accordance with the characteristics of students with visual learning styles, namely they tend to know what to say. At the stage of implementing the plan, students with a visual learning style have not been able to carry out the plans they have drawn up to solve problems. There are still errors in operation and it is still not complete in answering all the problems given. Based on its characteristics, students with visual learning styles sometimes lose concentration, so that they are still not right in implementing the plan. At the rechecking stage, students with a visual learning style have not rechecked every step that has been done.

4. Conclusion
Students with a visual learning style at the stage of understanding the problem are able to write and retell the problems given, but they are still incomplete. In understanding a problem, students with a visual learning style need other people's explanations and then write them down. In addition, students with a visual learning style understand the problem through an image. Based on their characteristics, students with visual learning styles tend to find it easier to capture and process information with visual associations. At the stage of preparing a plan, students with a visual learning style are able to explain the strategies to be used, but do not write the strategies on the answer sheet. This is in accordance with the characteristics of students with visual learning styles, namely they tend to know what to say. At the stage of implementing the plan, students with a visual learning style have not been able to carry out the plans they have drawn up to solve problems. There are still errors in operation and it is still not complete in answering all the problems given. Based on its characteristics, students with visual learning styles sometimes lose concentration, so that they are still not right in implementing the plan. At the rechecking stage, students with a visual learning style have not rechecked every step that has been done.

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