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# Students' Strategies in Solving PISA Mathematical Problems Reviewed from Problem-Solving Strategies

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***Abstract***

This study purposes to describe the strategies used by students in solving PISA type problems seen from the strategy of problem solving according to Polya. The research methodology is qualitative type descriptive study. Research subjects were 6 high school students in Palembang who had different levels of mathematical ability. Data was gathered using observation, interviews, and student answer sheets on the type of PISA questions given. The results showed that the dominant strategy used by students in solving PISA type problems included making pictures when they solve problem related to geometry; looking for possible answers systematically when they try to solve problem within numeric; writing information stated and the question when the problem is in the form of storytelling; and using trial and error when the problem provide answer alternatives.

**Keywords:** Students' Strategy¸ PISA-like Tasks, Problem Solving, Descriptive Study

**Abstrak**

Tujuan penelitian ini adalah untuk menggambarkan strategi yang digunakan siswa dalam menyelesaikan soal tipe PISA dilihat dari stategi menyelesaikan masalah menurut Polya. Metodologi penelitian yang digunakan adalah kualitatif tipe studi deskriptif. Subjek penelitian adalah 6 orang siswa sekolah menengah pertama di Palembang yang memiliki tingkat kemampuan matematika yang berbeda. Data dikumpulkan melalui observasi, wawancara, dan lembar jawaban siswa atas soal tipe PISA yang diberikan. Hasil penelitian menunjukkan bahwa startegi yang dominan digunakan oleh siswa dalam menyelesaikan soal tipe PISA diantaranya membuat gambar ketika soal PISA yang diberikan berupa soal tentang geometri; mencari kemungkinan jawaban secara sistematis ketika soal PISA yang diberikan memuat angka – angka; menuliskan bagian diketahui dan ditanyakan ketika soal PISA disajikan dalam bentuk soal cerita; dan strategi coba – coba ketika soal PISA yang diberikan memberikan pilihan jawaban.

**Kata kunci:** Strategi Siswa, Soal Tipe PISA, Pemecahan Masalah, Studi Deskriptif

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## INTRODUCTION

The Program for International Student Assessment (PISA) is an international scale test that is carried out every 3 years, which aims to test the performance of children in the world under 15 years old. It is held by the Organization for Economic Co-operation and Development (OECD). One of the tests is on mathematical literacy. The questions given on the PISA test contain all levels of thinking skills, both low and high levels (OECD, 2018). Problems at the level of lower-order thinking skills include questions that test the level of students' knowledge, understanding, and application, while questions on higher-order thinking skills require students' skills to analyze, evaluate, and be creative (Krathwohl, 2002; Brookhart, 2010). Higher-order thinking skills are one of the main focuses in learning according to the demands of the curriculum in Indonesia, namely the 2013 curriculum. This

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is because higher-order thinking skills have a role in supporting 21st century skills which include collaboration, communication, critical thinking, and creative skills (Griffin, 2014). These abilities are important for students to be mastered so that students are able to solve the problems faced and have competitiveness with other nations.

But in reality, the low ranking of Indonesian students according to the PISA results showed that Indonesian students were only able to solve questions related to knowledge, understanding, and even application. There were few questions at the level of higher-order thinking skills. This showed the lack of students' ability to solve problems that require analytical, evaluation, and creative skills (Stacey, 2011; OECD, 2018).

Previous researches related to PISA in mathematics learning have been carried out, including the development of PISA type questions using various life and cultural contexts (Kamaliyah, 2013; Fatmawati, 2016; Charmila, 2016; Putra, 2016; Permatasari, 2018; Murtiyasa, 2018; Nizar, 2018; Jannah, 2019; Dasaprawira, 2019; Pratiwi, 2019). In addition, other researches described the students' abilities such as reasoning skills (Anisah, 2011), students' argumentation (Sari, 2015), students' problem-solving abilities (Silva, 2011; Novita, 2012; Bidasari, 2017), mathematical communication skills (Mardhiyanti, 2011), mathematical literacy skills (Dewantara, 2015; Putra, 2016; Oktiningrum, 2016), argumentative skills (Fauziah, 2016), and creative abilities (Novita, 2016). Research on the results of students' error analysis in solving PISA questions has also been conducted by Wijaya (2014) and Sari (2017). The errors that occur are part of the students' efforts to solve the PISA questions. This relates to the student's process of solving problems. There are several strategies for students in solving problem, including the use of concrete objects, making pictures, making tables, writing what is known and asked in questions, experimenting, making patterns, arranging possible solutions systematically, working backwards, using open sentences, solve similar or easy problems, and change the point of view (Polya, 2004; Umar, 2016). However, studies on descriptions of how students solve PISA questions and what strategies students use when solving PISA questions in terms of problem-solving strategies were still very minimal. By understanding students' strategies in solving PISA-like mathematical problems, it becomes a consideration in designing the next learning series supporting improved students' skills. Therefore, this paper describes further the description of students' strategies in solving PISA math problems in terms of problem-solving strategies according to Polya.

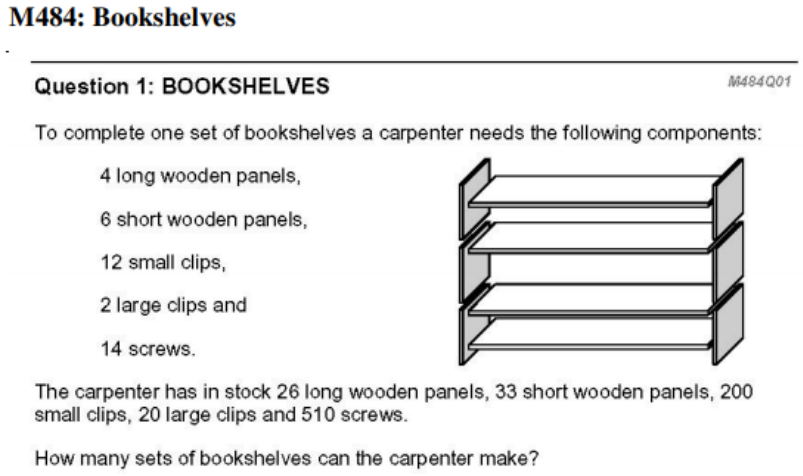
## METHODS

This is a qualitative research type descriptive study. It is a type of study that investigates the quality of materials, situations, activities or relationships. This type of research describes in detail what actually happens in an activity or situation or describes people's behavior rather than comparing effects (Novita, 2016). There are five steps in this research according to Fraenkel (2011), namely 1)

Identifying the phenomena being studied, this study describes students' strategies in solving math problems with the PISA type; 2) Identifying research subjects in the study, the research subjects were selected by purposive sampling, namely the selection of research subjects based on certain criteria, the criteria used were low, medium, and high mathematical abilities, the selection of research subjects was carried out with the help of subject teachers in schools, This study involved 6 7th grade students at Palembang Junior High School, consisting of 3 girls and 3 boys aged 13 years who have different abilities, namely high, medium, and low math abilities; 3) Generalizing the hypothesis, we estimate that in solving the PISA-type math problems, students will use various problem-solving strategies in solving these problems; 4) Collecting and analyzing data, student worksheets, observations, and interviews used to obtain in-depth information about the types of strategies students used when solving PISA questions. All data gathered through observation, interview, and student worksheet were classified into some type of students' strategy and were analyzed qualitatively in descriptive narration; 5) Interpreting and making conclusions, various types of problem-solving strategies are used as references as guidelines in interpreting and making conclusions.

## RESULTS AND DISCUSSION

In the preparation stage, the researcher prepared research instruments in the form of observation sheets, interviews, and PISA questions. Observation sheets and interviews were validated by 2 lecturers in the field of mathematics education, while the PISA questions used were existing PISA questions. There are 5 PISA questions given to students and students are asked to solve these questions. One of the PISA questions given is shown in Figure 1.



**M484: Bookshelves**

**Question 1: BOOKSHELVES** M484Q01

To complete one set of bookshelves a carpenter needs the following components:

4 long wooden panels,

6 short wooden panels,

12 small clips,

2 large clips and

14 screws.

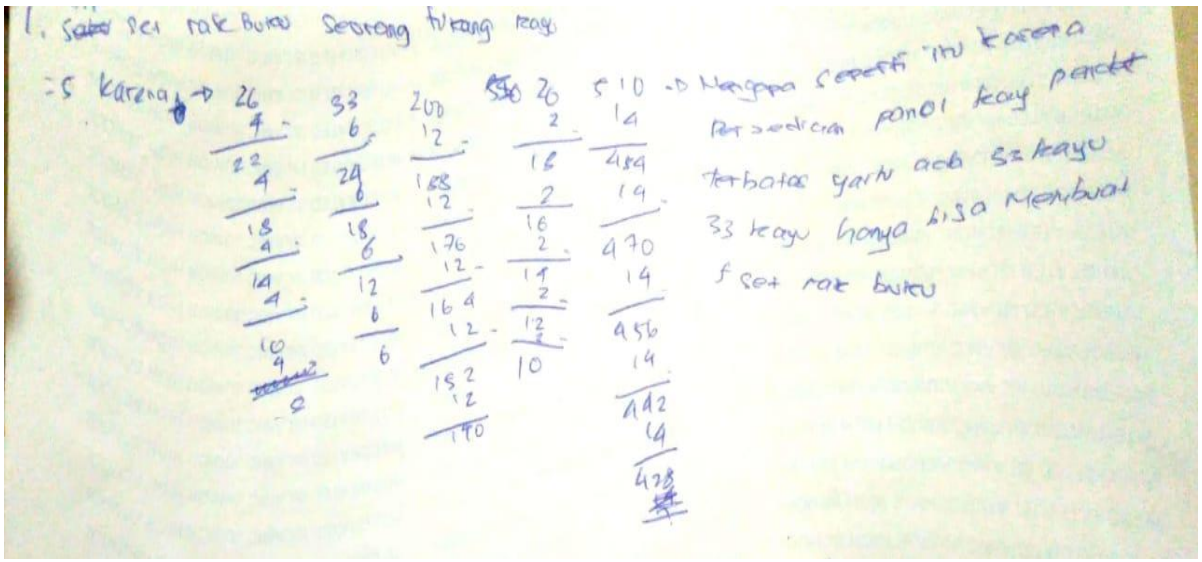
The carpenter has in stock 26 long wooden panels, 33 short wooden panels, 200 small clips, 20 large clips and 510 screws.

How many sets of bookshelves can the carpenter make?

**Figure 1.** One of PISA problems given with the context of a bookshelf

The PISA questions in Figure 1 which was given to students was original PISA questions published in 2009. This problem contains the problem of bookshelves numbers that carpenters can produce using a number of available materials. While students worked to solve the PISA questions

that had been given, the researcher observed and recorded things that needed to be asked of students during the interview. Students used certain strategies to solve these PISA questions. The following are the strategies students used in solving a given PISA type math problem.



**Translation:**

A carpenter's set of bookshelves = 5.

Why did it happen? it happened since the short supply of wood panel was limited, namely 33 logs. 33 wood could only make 5 sets of bookshelves

**Figure 2.** Students did the possibility of solving the problem

Figure 2 shows that in solving the questions given, students described the possibilities based on the information provided on the questions. The information given in the questions for making one bookshelf is the number of long pieces of wood as many as 4 pieces, the number of short woods as many as 6 pieces, as many as 12 small clips, 2 large clips, and 14 screws. The students were seen looking to find out how many bookshelves that could be made using materials provided by the carpenter. By considering the amount of material available, students tried to find out how many bookshelf units that could be made from this material. Students tried to reduce the available materials every time they made one set of shelves until the material was no longer sufficient to make another set of shelves. From the results of the calculations carried out by the students, it was seen that the short wood material had run out when the students reduced the material for the fifth time. So that the students decided the number of bookshelves is 5 units. The strategy used by these students is one of the problem-solving strategies, namely the strategy of arranging the possibility of solving problems systematically based on the information provided by organizing data based on certain categories.

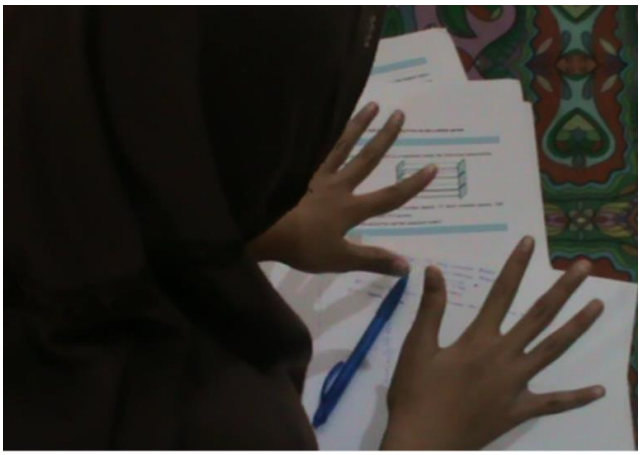


**Figure 3.** Students tried to count using their fingers

Figure 3 shows how the students found the results of the calculation of subtraction using their fingers. The subtraction process was used by students to determine how many times they reduced the process until the number of materials was reduced. Then the student counted the number of subtraction processes that he did on the material with the fastest reduction. To support the results of observations and analysis of the student worksheets, here is a transcript of the results of the interview between the researcher symbolized by P and the student symbolized by R.

P : *What was number 1 about, R?*

R : *How many sets of bookshelves*

P : *How many sets of bookshelves*

R : *Yes, the carpenter, for example, he had more materials.*

P : *Ehm.. let me see, R. Why would R use a subtraction like that?*

R : *I got 5 units, Mam.*

P : *5 units*

R : *The short wooden panel is only 33. So, if the shelf were more than 5, then the short panel wood must be more than 33*

P : *Then, I saw that you used your fingers. What did that mean??*

R : *Hehe.. I did subtraction*

P : *Oh, this subtraction process (pointing to the subtraction part on the worksheet) Did you use your fingers, didn't you? How many shelves did you get?*

R : *5, Mam.*

The transcript of the conversation above shows that the students understood the PISA questions given. In solving these questions, students carried out a calculation process with a number subtraction operation. In each number of materials provided, students carried out a process of reducing the nominal value of the material until the nominal was close to 0 or the material was not enough to make another set of bookshelves. The students concluded that with 33 panels of short panel wood, only enough to make 5 bookshelves. According to him, if a carpenter wanted to make more than 5

bookshelves, the panel wood might be more than 33 panels. Different strategies were carried out by students on other different types of questions, as shown in the following figure.

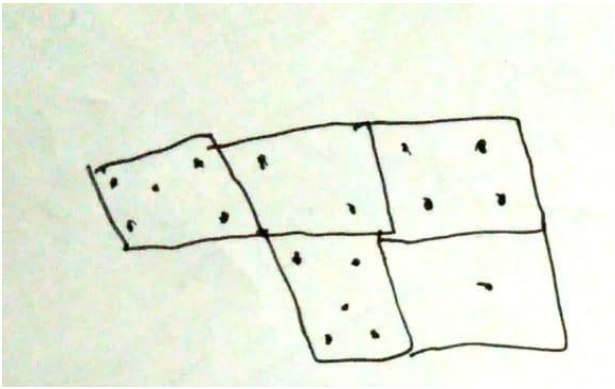
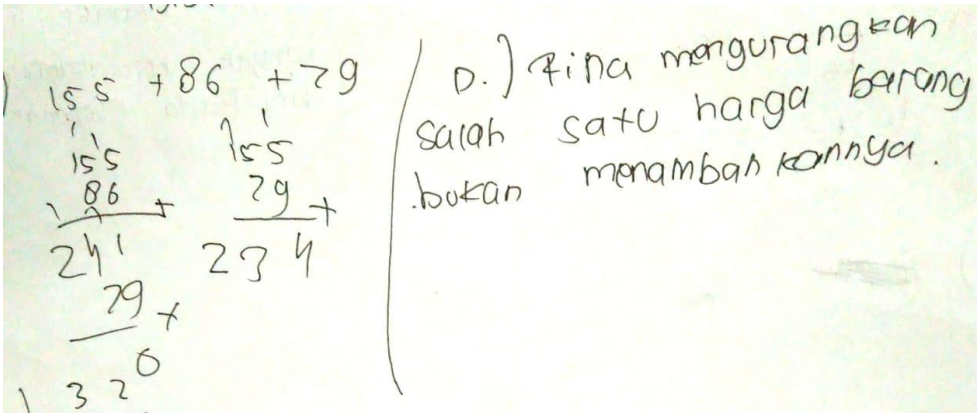


**Figure 4.** Students made pictures in solving PISA questions

Figure 4 shows one of the sketches made by students in solving the PISA questions given. The PISA problem given was about counting the number of dice points that appear from above from the construction of 6 dice arranged in a stack. To solve this problem, most students sketched the appearance of the dice when viewed from the top side. Both the structure of the arrangement and the location of the dice points were able to be described well by the students, the sketches they made were in accordance with the actual conditions of the dice. The strategy carried out by students by making pictures of the problems given is one of the problem-solving strategies. The strategy of making pictures carried out by students aims to make it easier for students to determine the number of dice points that appear from the top side. Not all of the dice points are clearly visible in the picture given in the question. This is because the arrangement of the dice on the back is blocked by the dice on the front so students need to think about how many points the dice actually have. Therefore, to help students determined the number of dice points, students tried to visualize the appearance of the dice arrangement when seen from above.

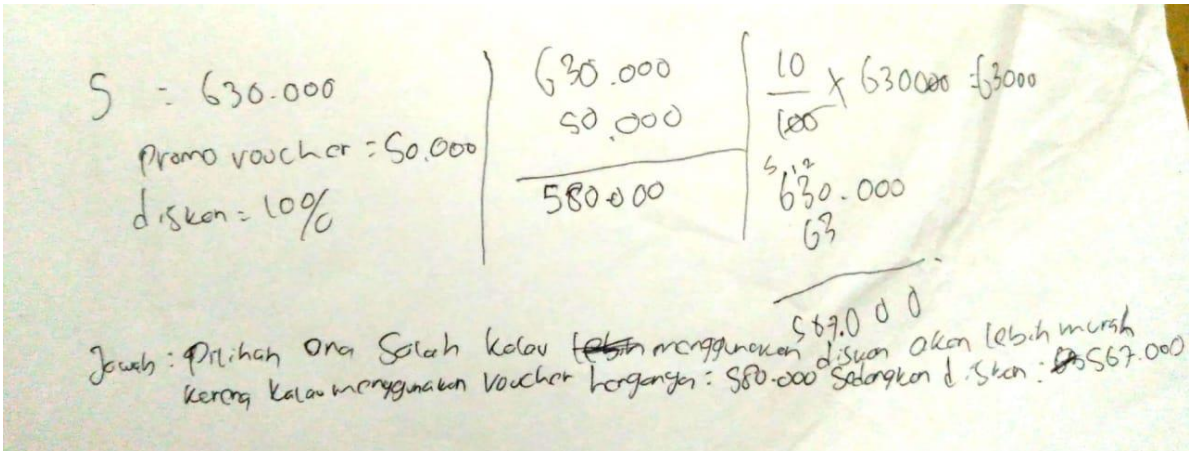



**Translation:**

D). Rina subtracted one item price instead of adding it

**Figure 5.** Students tried several alternative answers given

Figure 5 is one of the strategies used by students in solving the PISA questions given. Students tried to calculate the value that is in the alternative answer. If the value obtained was not close to the value asked, students tried to check other alternative answers. After the scores were obtained and approached, students determined the correct answer that was the answer to these alternatives. The strategy used by these students was one of the problem-solving strategies, namely the trial-and-error strategy. The trial-and-error strategy is generally carried out by students because students do not know the formula or pattern in the questions. Especially if the questions are included with alternative answers. So that students tend to look for answers through trying out the alternative answers given.




**Translation:**

The answer: Ona's choice was wrong. When she used a discount it would be cheaper because using a voucher the price was 580.000 while the discount was 567.000.

**Figure 6.** Students wrote down the information they know and are asked about the questions

Figure 6 is one of the solutions made by students to answer the PISA questions given. In this picture, it can be seen that students write down known information and use it in solving problems. The question given was about checking the correctness of the statement given in the question, namely about the accuracy of using the shopping voucher or discount given. The student calculated the voucher value and the discount value given to check the correctness of the statement. After getting the final calculation, students decided that the statement was false. The student's strategy of writing down information that is known and asked in the questions is one of the problem-solving strategies. This strategy is generally carried out by students to formulate appropriate settlement steps based on the information provided in the questions by carrying out a calculation process that involves this information.

Most of students try to understand PISA-like mathematical problems given before they start solving the problems. After they got what problem is about, sometimes they write down some information or they make some drawing representing the situation. They decide and apply their strategies in finding the answer of problem through systematic calculation, trial and error or, even

guessing the answer. Sometimes students just get the final number as the answer and not really sure whether the answer is correct or not. This is in line with problem solving steps according to Polya (2004) namely: understanding the problem, determining strategies, applying strategies, and looking back the answer.

Most students perform number operations such as addition, subtraction, multiplication or division for PISA questions that involve numbers. Especially for the PISA questions given, most of the students performed subtraction operations. According to Tabach (2013), in solving numeric questions, students will look for patterns and find answers by numerical operations. Students use the strategy of making pictures to help them in solving PISA type problems, especially, in geometry topics. Most of the students made pictures in solving the problem about counting the number of dice points that were seen from the top side of the dice pile. This is in line with the results of research conducted by Ristiana (2015) where students used the strategy of making pictures in solving rectangular story problems. Moreover, according to Van Gardegeren (2003), the use of visual-spatial representations has a positive and significant correlation with students' mathematical problem-solving performance. Students try to investigate the truth of the answer choices given for the types of PISA questions that provide answer choices. According to Yani (2019), students tend to use guesswork and try-out strategies from the student's answer choices given. Sometimes students do not feel confident about the answers obtained from the guesswork and trial and error strategy (Ramadhan, 2017). While PISA questions are presented in the form of stories, the strategy most students use is to write down the information and questions in the questions. This is in line with previous research that students generally write down things that are known and asked about in story problems (Rindyana, 2012; Anwar, 2013; Istiqomah, 2014; Farida, 2015; Nugroho, 2017; Oktaviana, 2017).

## CONCLUSION

Students use several problem-solving strategies in solving PISA-type math problems, including strategies for arranging possible solutions systematically, especially in questions that involve numeric (numbers) students repeating number operations; strategies for making drawings, especially on the topic of geometry; carry out trial and error strategies, especially on questions that provide several alternative answers; and strategies to write down information and questions in the questions, especially in the PISA questions in the form of stories. Understanding how students 'strategies in solving PISA type questions can provide an overview of how students work with these questions and become the basis for designing next learning steps to support students' abilities at the next level.

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**REFERENCES**

Anisah, A., Zulkardi, Z., & Darmawijoyo, D. (2011). Developing PISA model mathematical problem on quantity content to measure the mathematical reasoning abilities of junior high school students [in Bahasa]. *Jurnal Pendidikan Matematika*, *5*(1), 1-15. DOI: https://doi.org/10.22342/jpm.5.1.333.

Anwar, S. (2013). The use of Polya's problem solving steps in solving story questions on comparative material in class VI Mial-Ibrohimy Galis Bangkalan [in Bahasa]. *MATHEdunesa*, *2*(3), 1-6.

Bidasari, F. (2017). PISA model mathematics problem development on quantity content to measure junior high school students' mathematical problem-solving ability [in Bahasa]. J*urnal Gantang, 2*(1), 63-77. DOI: https://doi.org/10.31629/jg.v2i1.59.

Brookhart, S. M. (2010). *How to assess higher-order thinking skills in your classroom*. ASCD.

Charmila, N., Zulkardi, Z., & Darmawijoyo, D. (2016). PISA model mathematical problem development using Jambi Context [in Bahasa]. *Jurnal Penelitian dan Evaluasi Pendidikan, 20*(2), 198-207. DOI: https://doi.org/10.21831/pep.v20i2.7444.

Dasaprawira, M. N. (2019). Developing mathematics questions of PISA type using Bangka context. *Journal on Mathematics Education*, *10*(2), 303-314. DOI: https://doi.org/10.22342/jme.10.2.5366.303-314.

Dewantara, A. H., Zulkardi, Z., & Darmawijoyo, D. (2015). Assessing seventh graders' mathematical literacy in solving PISA-like tasks. *Journal on Mathematics Education, 6*(2), 117-128. DOI: https://doi.org/10.22342/jme.6.2.2163.117-128.

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2011). How to design and evaluate research in education. New York: McGraw-Hill Humanities/Social Sciences/Languages.

Farida, N. (2015). Analysis of the errors of grade VIII junior high school students in solving math problem problems [in Bahasa]. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *4*(2), 42-52. DOI: http://dx.doi.org/10.24127/ajpm.v4i2.306.

Fatmawati, D. (2016). Development of PISA-like math problems on change and relationship content for junior high school students [in Bahasa]. *MATHEdunesa*, *5*(2), 29-38.

Fauziah, A. (2016). PISA type mathematical problem design on uncertainty content and data to know the argument ability of junior high school students [in Bahasa]. In National Seminar and Workshop on PISA 2016.

Griffin, P., & Care, E. (Eds.). (2014). *Assessment and teaching of 21st century skills: Methods and approach*. Springer.

Istiqomah, N. (2014). The thinking process of junior high school (SMP) students in solving math story problems based on cognitive style on curved side space building material [in Bahasa]. *MATHEdunesa, 3*(2), 144-149.

Jannah, R. D., & Putri, R. I. I. (2019). Soft tennis and volleyball contexts in Asian Games for PISA-like mathematics problems. *Journal on Mathematics Education, 10*(1), 157-170. DOI: https://doi.org/10.22342/jme.10.1.5248.157-170.

Kamaliyah, K., Zulkardi, Z., & Darmawijoyo, D. (2013). Developing the sixth level of PISA-like mathematics problems for secondary school students. *Journal on Mathematics Education, 4*(1), 9-28. DOI: https://doi.org/10.22342/jme.4.1.559.9-28.

Krathwohl, D. R. (2002). *A revision of Bloom's taxonomy: An overview. Theory Into Practice, 41*(4), 212-218.

Mardhiyanti, D., Ilma, R., & Kesumawati, N. (2011). Developing PISA-like mathematics problems to measure students' mathematical communication ability in elementary school [in Bahasa]. *Jurnal Pendidikan Matematika, 5*(1). DOI: https://doi.org/10.22342/jpm.5.1.334.

Murtiyasa, B., Rejeki, S., & Setyaningsih, R. (2018). PISA-like problems using Indonesian contexts. *Journal of Physics: Conference Series, 1040*(1), 1-9.

Nizar, H., & Putri, R. I. I. (2018). Developing PISA-like mathematics problem using the 2018 Asian Games football and table tennis context. *Journal on Mathematics Education, 9*(2), 183-194. https://doi.org/10.22342/jme.9.2.5246.183-194.

Novita, R. (2012). Exploring primary student's problem-solving ability by doing tasks like PISA's question. *Journal on Mathematics Education, 3*(2), 133-150. DOI: https://doi.org/10.22342/jme.3.2.571.133-150.

Novita, R., & Putra, M. (2016). Using task like PISA's problem to support student's creativity in mathematics. *Journal on Mathematics Education, 7*(1), 31-42. https://doi.org/10.22342/jme.7.1.2815.31-42.

Nugroho, R. A. (2017). Analysis of students' difficulties in finishing story questions on fraction material in terms of Polya's problem solving [in Bahasa]. Skripsi. Universitas Muhammadiyah.

OECD. (2018). *PISA 2015 : PISA results in focus*. Paris: OECD.

Oktaviana, D. (2017). Error type analysis based on Newman's theory in solving story problems in discrete mathematics courses [in Bahasa]. *Edu Sains: Jurnal Pendidikan Sains & Matematika, 5*(2), 22-32.

Oktiningrum, W., Zulkardi, Z., & Hartono, Y. (2016). Developing PISA-like mathematics task with indonesia natural and cultural heritage as context to assess students mathematical literacy. *Journal on Mathematics Education*, 7(1), 1-8. DOI: https://doi.org/10.22342/jme.7.1.2812.1-8.

Permatasari, R., & Putri, R. I. I. (2018). PISA-Like: Football context in Asian Games. *Journal on Mathematics Education, 9*(2), 271-280. https://doi.org/10.22342/jme.9.2.5251.271-280.

Polya, G. (2004). *How to solve it: A new aspect of mathematical method* (Vol. 85). Princeton: University Press.

Pratiwi, I., & Putri, R. I. I. (2019). Long jump in Asian Games: Context of PISA-like mathematics problems. *Journal on Mathematics Education, 10*(1), 81-92. https://doi.org/10.22342/jme.10.1.5250.81-92.

Putra, Y. Y., Zulkardi, Z., & Hartono, Y. (2016). PISA model level 4, 5, 6 mathematical problem development using Lampung context [in Bahasa]. *Kreano, Jurnal Matematika Kreatif-Inovatif*, 7(1), 10-16. https://doi.org/10.15294/kreano.v7i1.4832.

Putra, Y. Y., Zulkardi, Z., & Hartono, Y. (2016). Development of PISA mathematical problems with number content to determine students' mathematical literacy ability [in Bahasa]. *Jurnal Elemen*, *2*(1), 14-26.

Ramadhan, M., Sunardi, S., & Kurniati, D. (2017). Analysis of student misconceptions in solving pisa standard mathematical problems using Certainty Of Response Index (CRI) [in Bahasa]. *KadikmA, 8*(1), 145-153.

Rindyana, B. S. B., & Chandra, T. D. (2012). Analysis of students' errors in solving math story problems on the two-variable linear equation system material based on Newman's analysis (Case Study in MAN Malang 2 Batu) [in Bahasa]. *Artikel Ilmiah Universitas Negeri Malang*, 1(2).

Ristiana, M., Ratu, N., & Yunianta, T. N. H. (2015). Problem solving strategies in solving story problems on equations and linear one variable inequality material for class VII A students at SMP Kristen 02 Salatiga. *Satya Widya, 31*(1), 8-16.

Sari, E. F. P. (2015). Developing PISA model mathematical problem to find out the arguments of students in junior high schools [in Bahasa]. *Jurnal Pendidikan Matematika*, *9*(2), 124-147. https://doi.org/10.22342/jpm.9.2.2429.124%20-%20147.

Sari, Y. M., & Valentino, E. (2017). An analysis of students error in solving PISA 2012 and its scaffolding. *JRAMathEdu (Journal of Research and Advances in Mathematics Education), 1*(2), 90-98.

Silva, E. Y., Zulkardi, Z., & Darmawijoyo, D. (2011). PISA model mathematical problem development based on uncertainty content to measure the mathematics problem solving ability of junior high school students [in Bahasa]. *Jurnal Pendidikan Matematika*, *5*(1). https://doi.org/10.22342/jpm.5.1.335.

Stacey, K. (2011). The PISA view of mathematical literacy in Indonesia. *Journal on Mathematics Education, 2*(2), 95-126. https://doi.org/10.22342/jme.2.2.746.95-126.

Tabach, M., & Friedlander, A. (2013). School mathematics and creativity at the elementary and middle-grade levels: how are they related?. *ZDM*, *45*(2), 227-238. https://doi.org/10.1007/s11858-012-0471-5.

Umar, W. (2016). George Polya's version of mathematical problem solving strategies and their application in mathematics learning [in Bahasa]. *Kalamatika: Jurnal Pendidikan Matematika*, 1(1), 59-70. https://doi.org/10.22236/KALAMATIKA.vol1no1.2016pp59-70.

Van Garderen, D., & Montague, M. (2003). Visual-spatial representation, mathematical problem solving, and students of varying abilities. *Learning Disabilities Research & Practice, 18*(4), 246-254. https://doi.org/10.1111/1540-5826.00079.

Wijaya, A., van den Heuvel-Panhuizen, M., Doorman, M., & Robitzsch, A. (2014). Difficulties in solving context-based PISA mathematics tasks: An analysis of students' errors. *The Mathematics Enthusiast, 11*(3), 555-584.

Yani, M. (2019). The effectiveness of distractors on multiple choice tests to detect student errors in solving mathematical problems [in Bahasa]. *Al Khawarizmi: Jurnal Pendidikan dan Pembelajaran Matematika*, *2*(2), 125-138. http://dx.doi.org/10.22373/jppm.v2i2.4502.