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Students' Self Regulated Thinking Profiles In Overcoming Math Problems

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Abstract
The results of tests conducted by PISA and TIMSS expose that students' mathematics mastery in Indonesia included in low category. The students show difficulties in processing their thought and solving problems to understand mathematics concepts. By then, this study aims to analyze the students' thinking process in solving mathematics matters. The researcher identified clearly and in detail about Self Regulated Thinking (SRT) for some students who had succeeded in solving math questions. The research design applied in the present study is case study. The data and data sources are the results of data test for eight grade 15 years old students. Data obtained from analysis of test results and interviews with respondents. Data analysis uses qualitative techniques which include three stages, namely data reduction, data presentation, and drawing conclusions. The results showed that the students basically have skills in monitoring their own thoughts, determining appropriate problem solving plans, identifying and using the existing learning sources, providing responses or feedback, and evaluating the effectiveness of their own actions. The students also expressed different way in implementing self regulated thinking (SRT). Accordingly, mathematics teachers need to design mathematics lesson that provides opportunity for students to express and improve their thinking skills..

Keywords: Self regulated thinking (SRT), math problems, thinking process

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INTRODUCTION

Mathematics contributes greatly to the advancement of modern science and technology (Delen & Bulut, 2011; Kermani & Aldemir, 2015). It is not surprising that mathematics is taught in almost all levels of education throughout the world. Some countries realize that teaching mathematics well to students also means to prepare the next generation to master technological and scientific advances (Ozgen & Bindaka, 2011; Pradana et al., 2020). Besides the belief that those who master mathematics will not only produce great scientists or engineers, but also good citizens (Li & Schoenfeld, 2019).

Unfortunately, the mathematics scores of Indonesian students are very apprehensive (Argina et al., 2017). Among the test results on Indonesian students' mathematical skill that are commonly used as references considering their credibility are PISA (Programme International for Student Assessment) and TIMSS (The Trends of International Mathematics and Science Study). PISA measures the ability of 15-year-olds in math, science and reading. TIMSS and PISA's mathematics proficiency tests involve many countries around the world. TIMSS and PISA place Indonesian students as a country with very low mathematical abilities for several times (Stacey, 2011; Tohir, 2019).

PISA assesses students' abilities in terms of the ability to identify, understand, interpret, create, communicate, and count. The results of this assessment are obtained through a problem test that is packaged through questions related to everyday life where students solve them based on the knowledge they already have (Stacey, 2011). The final achievement scores of Indonesian students in the PISA average for mathematics, science, and reading are still in the low category. This happens because the scores of Indonesian students are still below the average achievement set by the Organization for Economic Cooperation and Development (OECD). For example, TIMSS results in 2015 showed that the average math score of Indonesian children was 386. Meanwhile, the highest OECD average score for mathematics was 494 (Kartianom & Retnawati, 2018; Naumann & Sälzer, 2017; Pakpahan, 2016).

The results of mathematics test for Indonesian students conducted by TIMSS showed not many differences (Hadi & Novaliyosi, 2019; Kartianom & Retnawati, 2018). TIMSS measures the ability of children in grades 4 and 8 for mathematics and science (Fenanlampir et al., 2019). The following is the ranking of Indonesian students' ability year to year.

Table 1. The Result of TIMSS

The Result of TIMSS			
Year	Rank	Indonesian Average Score	International Average Score
2003	35	411	467
2007	36	397	500
2011	38	386	500
2015	44	397	500

The data shows that Indonesia's ranking continues to decline from year to year from 2003 to 2015. In 4 times Indonesia's participation did not show any significant changes. Meanwhile, in 2019, Indonesia is no longer involved in the study conducted by TIMSS. The low result for mathematical ability of Indonesian students have a mean that there are some problems with mathematics learning system in Indonesia. Mathematics learning which is expected to foster the ability to think systematically, logically, critically cannot be realized (Rambe et al., 2020). Students just have procedural or computational abilites. Moreover, learning mathematics should provide some opportinities for students to construct their own understanding. In this way, students will increase their confidence because they feel that they have found a concept through their efforts (Ozgen & Bindaka, 2011).

Positioning students as individuals who already have a mature mindset is not an exaggeration. Because basically adult students are capable enough to manage their own thinking skills (Rowais, 2019). When someone faces a problem, s/he can do Self Regulated Thinking to deal with the problem. Self-Regulated Thinking is the ability of students to monitor their own thoughts, determine appropriate problem-solving plans, identify and use existing learning resources, provide responses or feedback, and evaluate the effectiveness of their own actions (Marzano & Pickering, 1997).

Monitoring self thoughts means learning to understand what is thought by our own mind. This process begins by asking questions for our own mind (Cakici, 2018). There are several words that can be used to monitor thoughts. The interrogative sentence 'how' is used to obtain information about a procedure or steps. Meanwhile, to obtain information about the situation or knowledge used the word 'why' (Lee, 2001).

Students who have SRT abilities will be able to determine the right problem solving plan because students are able to choose methods, define goals, identify the steps needed to achieve goals, anticipate problems, assess responses, and determine the right

time (Lee, 2001). Yew and Zamri (2016) suggest that proper planning in solving mathematical problems can be done by drawing strategies, making lists, trial and error, and identifying sentences that can help solve problems.

There have been many research themes surrounding students' independence in managing themselves. However, in contrast to self-regulated learning (SRL) which has received much attention from researchers (Boekaerts, 1999; Bransen et al., 2022; Hong et al., 2021; Zimmerman, 1990), research on self-regulated thinking (SRT) is not studied widely by researchers, especially in the context of learning mathematics in Indonesia. Based on the search results using the Harzing's Publish Or Perish application, in the google scholar database in the period 2000 to 2022 there are only 10 articles that use the title word "self-regulated thinking" in its entirety. Hence, this study aims to explore the Self Regulated Thinking profile of students in Indonesia in dealing with mathematical problems.

METHODS

This research is a qualitative research. Qualitative research was chosen because it is able to identify clearly and in detail a phenomenon, namely the ability of self-regulated thinking (SRT) of students who have successfully solved mathematical problems. The data and data sources that will be used in this study are the results of the 8th grade students' test data at MTs Darul Hikmah Tawang Sari in solving math problems. In addition to student test data. Data in the form of documentation of student answers in the form of pictures or photos are also used by researchers in identifying students' Self Regulated Thinking (SRT). This study involved 4 purposively selected respondents, namely 8th grade students, aged 15 years and classified as students with abilities above the average of other students. Data analysis used in this study is qualitative data analysis which includes three important activities, namely data reduction, data presentation, and drawing conclusions.

RESULTS & DISCUSSION

Results

Before presenting the research data, the researcher needs to explain the SRT units that are used in this study. It's shown at table 2.

From the results of data collection, the research subjects obtained as many as 4 students who have successfully completed the test in the form of mathematical problems correctly.

Self Regulated Thinking S1

Here is the answer for S1 after being given the PISA test 6 level

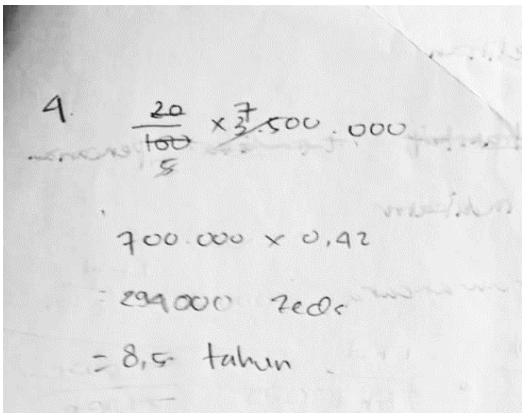

Figure 1. S1 Answer

S1 answers the questions given with the correct answer, which is 8.5 years. He multiplied 20% by 3500000. The result of the multiplication was 700000. Then he multiplied 700000 again by 0.42 and used it as a divisor of 2500000 to get 8.5.

Teble 2. SRT Unit and SRT Strategy

SRT UNITS	INDICATOR
Monitoring self-thinking	understand what our own mind is thinking by raising various kinds of questions such as 1. ask the procedure or steps by asking "How", 2. ask the situation or the knowledge needed by using "Why" and "When"
Determine the correct problem solving plan,	1. define goals, 2. identify the steps needed to achieve the goals, 3. anticipate problems, assess responses, 4. and determine the right time
Identify and use existing learning resources,	1. ask a friend, 2. ask the teacher, 3. looking for information from books, 4. looking for information from the internet
Give a response or feedback	1. listen to some input from others by implementing open minded attitude 2. refute the feedback if it is deemed inappropriate.
Evaluating the effectiveness of self actions	1. observing the process that occurs in ourselves. 2. Assessing ourselves at work, 3. see what we are trying to finish, 4. and evaluate the success we have made.

The results of the S1 Self Regulated Thinking (SRT) analysis in solving PISA level 6 questions are as follows:

Monitoring Self – Thinking

The results of the work written by S1 do not attach what is known and asked in the question. However, he stated that he knew what was needed to find a solution to the given problem. S1 deliberately did not write on the answer sheet what was known and what was asked because just by thinking about it he could understand so there was no need to write it down in the answer sheet. S1 is able to understand what is being thought at the time of problem solving. This means that S1 has been able to carry out the Self Regulated Thinking process in the first stage, namely monitoring his own thoughts.

Determining the Correct Problem Solving Plan

In the second stage, which is designing properly, S1 has carried out several processes in Self Regulated Thinking. S1 initially had trouble solving the given problem. However, he tries to think of goals and plans to solve problems in a systematic way. The objective is to find out in what year the fuel savings can replace the money for the purchase of the ship. S1 also has a strategy or way to solve the problem. He does this by calculating 20% multiplied by the annual consumption of kites.

Identifying and Using the Existing Learning Resources

In the third Self-Regulated Thinking (SRT) process, namely recognizing and determining the required resources, it shows that S1 has been able to recognize and use the required resources properly. He tried to find as much information as possible to solve the problem by asking the teacher and his friends. Teachers are felt to have more knowledge to help find a way out in dealing with problems. This means that students are able to identify and determine what is needed to solve the problem.

Giving Response and Feedback

In the fourth Self Regulated Thinking (SRT) process, namely give response or feedback, S1 was able to do it. S1 stated that he was very sure that he was right with the answer, starting from the initial steps of the process to the final result. This happens because he works on his own according to his thoughts which are considered correct. He is very confident in his achievements and still holds that the answer is correct. This shows that S1 is able to hear input that is in accordance with what is the problem and refutes things that are not in accordance with the context being discussed. The feedback provided by S1 has been very good.

Evaluating The Effectiveness of Self Action

In the last process, Self-Regulated Thinking is evaluating the effectiveness of self actions. S1 evaluates his work quite well. It has another way of evaluating material. S1 was annoyed by the noisy environment, but he still tried to focus. This means that S1 is able to evaluate the strategy and effectiveness of its actions. From the description of the results of the analysis above, it shows that S1 has done Self Regulated Thinking (SRT) in solving problems.

Self Regulated Thinking S2

Here is the answer of S2 after being given PISA test level 6

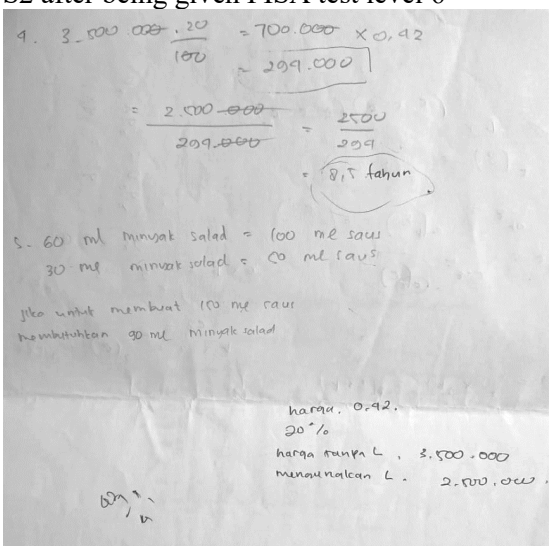

Figure 2. S2 Answer

S2 answers the questions given with the correct answer, which is 8.5 years. He multiplied 20% by 3500000. The result of the multiplication was 700000. Then he multiplied 700000 again by 0.42 and used it as a divisor of 2500000 to get 8.5.

The results of the S2 Self Regulated Thinking (SRT) analysis in solving Pisa level 6 questions are as follows:

Monitoring Self Thinking

The results of the work written by S2 deliberately did not write down what was known and what was asked. But he also stated that he knew what it meant. S2 deliberately did not write on the answer sheet because just by thinking about it he could understand so there was no need to write it on the answer sheet. S2 is able to understand what is being thought at the time of problem solving. This means that S2 is able to carry out the Self Regulated Thinking process in the first stage, namely monitoring his own thoughts.

Determining Correct Problem Solving Plan

In the second stage, which is planning properly, S2 has carried out several processes in Self Regulated Thinking. S2 was initially confused about solving the given problem. However, he tries to think of goals and plans to solve problems in a systematic way. The objective is to find out in what year the fuel savings can replace the money for the purchase of the ship. S2 also has a strategy or way to solve the problem. He does this by calculating 20% multiplied by the annual consumption of kites.

S2 stated that he planned the time needed. Although he could not reveal how many minutes it would take and only stated as soon as possible it should be completed. However, he didn't think of any other way of anticipating problems and assessing responses. This situation shows that S2 has carried out the second Self Regulated Thinking process even though there is one indicator that is not fulfilled, namely planning another method to solve the problem.

Identifying and Using the Existing Learning Resources

In the third Self Regulated Thinking (SRT) process, namely identifying and determining the required resources. S2 has been able to recognize and use the required resources well. He tried to find as much information as possible to solve the problem by asking the teacher. Teachers are felt to have more ability to help find a way out in dealing with problems. This means that students are able to identify and determine what is needed to solve the problem.

Giving Response and Feedback

In the fourth Self Regulated Thinking (SRT) process, namely responding to feedback, S2 was able to do it. S2 stated that he was very sure that he was right with the answer, starting from the initial steps of the process to the final result. This happens because he tries to work on his own according to what he thinks is right. He is very confident in his achievements and still holds that the answer is right. When the researcher tried to shake the answer, he was actually able to argue that what the researcher said was not appropriate. This shows that S2 is able to listen to input openly and refute feedback when S2 feels it is not appropriate.

Evaluating The Effectiveness of Self Action

In the last process, Self-Regulated Thinking is evaluating the effectiveness of self actions. S2 does not have other methods for evaluation materials. He was just sure that what he was doing was done right. S2 is also able to respond to the researcher's response regarding his method. He finds it easier to use the methods he uses. S2 was annoyed by the noisy surroundings, but he was still able to focus. This means that S2 is able to evaluate the strategy and effectiveness of its actions.

From the description of the results of the analysis above, it shows that S2 has done Self Regulated Thinking (SRT) in solving problems. However, there is a Self Regulated Thinking (SRT) process that has not been fully fulfilled. This is because S2 has not been able to think of other strategy or methods.

Self Regulated Thinking S3

Here is the answer of S3 after being given PISA test 6 level

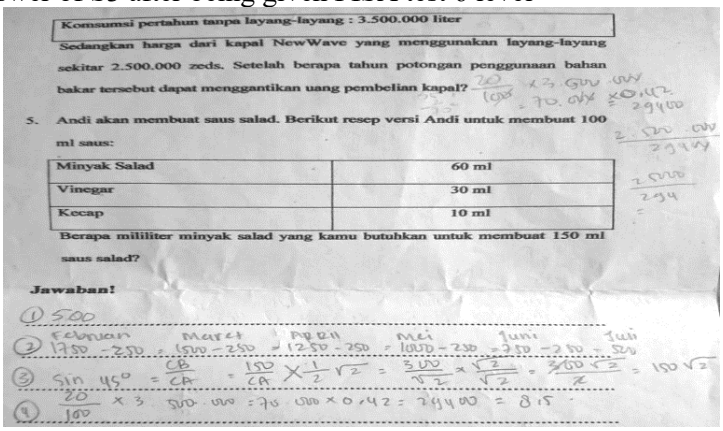

Figure 3. S3 Answer

S3 answers the questions given with the correct answer, which is 8.5 years. He multiplied 20% which is equal to 20/100 by 3500000. The result of this multiplication is 700000. From 700000 he multiplied again by 0.42 and used as a divisor of 2500000 to get the final result 8.5. However, in writing on the answer sheet he was less coherent and systematic.

The results of the S3 Self Regulated Thinking (SRT) analysis in solving Pisa level 6 questions are as follows:

Monitoring Self-Thinking

The results of the work written by S3 have a mean that s/he understands what is known and asked, without writing it on the answer sheet. It also states that what is asked and what is known is appropriate. S3 is able to understand what is being thought at the time of problem solving. This means that S3 is able to carry out the Self Regulated Thinking process in the first stage, namely monitoring his own thoughts.

Determining Correct Problem Solving Plan

In the second stage, which is to design properly, S3 has carried out several processes in Self Regulated Thinking. At the time of solving the problem S3 encountered problems. The obstacle is experiencing confusion at the beginning of the solution. But he tried to think of goals and plans to solve the problem. The purpose in question is to find the number of years that can replace the money for buying a ship by saving fuel. S3 also has a strategy or way to solve the problem but S3 doesn't think of any other way.

Identifying and Using the Existing Learning Resources

In the third Self-Regulated Thinking (SRT) process, namely recognizing and determining the required resources, the results of the interviews showed that S3 was able to recognize and use the required resources properly. To solve the problem he tried to collect as much information as possible from the teacher. The teacher was considered the one major resource he needed at the time. This means that S3 is able to do the third Self-Regulated Learning (SRT), which is to recognize and determine what is needed to solve the problem.

Giving Response and Feedback

In the fourth Self Regulated Thinking (SRT) process, which is responding to feedback, S3 has been able to do it. S3 stated that he was quite sure that he was right with his answer. This happened because he tried to work on his own according to what he thought was correct. He has confidence in the results of his achievements and still holds that the answer is correct even though the researcher tries to shake the answer. S3 was also able to refute that what the researcher said was not appropriate. This shows that S3 is able to listen to input openly and refute feedback when S3 feels it is not appropriate.

Evaluating The Effectiveness of Self Action

In the last process of Self Regulated Thinking, which is evaluating the effectiveness of self actions, S3 does not have other strategies/methods for evaluation materials. It can only evaluate in the same way. S3 also revealed that the research method

was easier and the method is less effective. This means that S3 is able to evaluate the strategy and effectiveness of his actions.

From the description of the results of the analysis above, it shows that S3 has done Self Regulated Thinking (SRT) in solving problems. However, there is a Self Regulated Thinking (SRT) process that has not been fully fulfilled. This is because S3 has not been able to think of other strategic methods and has not been able to estimate the time to solve the problem.

Self-Regulated Thinking S4

Here is the answer for S4 after being given the PISA test 6 levelel

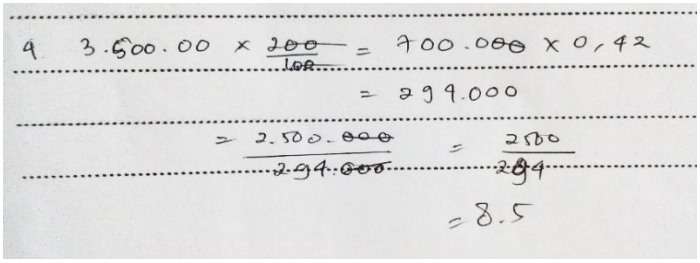

Figure 4. S4 Answer

S4 answers the questions given with the correct answer, which is 8.5 years. He multiplied 20% which is equal to 20/100 by 3500000. The result of this multiplication is 700000. From 700000 he multiplied again by 0.42 and used as a divisor of 2500000 to get the final result 8.5. However, in writing on the answer sheet he was less coherent and systematic.

The results of the S4 Self Regulated Thinking (SRT) analysis in solving Pisa level 6 questions are as follows:

Monitoring Self-Thinking

The results of the work written by S4 have a mean that he already understands what is known and asked without writing it on the answer sheet. S4 is able to understand what is being thought at the time of problem solving. This means that S4 is able to carry out the Self Regulated Thinking process in the first stage, namely monitoring his own thoughts.

Determining the correct problem solving plan,

In the second stage, which is to properly design the S4, it has carried out several processes in Self Regulated Thinking. S4 experiences confusion at the beginning of the solution. But he tried to think of goals and plans to solve the problem. The purpose in question is to find the number of years that can replace the money for buying a ship by saving fuel. S4 stated that he did not plan the time required. In addition, he also did not think of other ways to anticipate problems and assess responses. From the results of the analysis above, it can be seen that S4 has carried out the second Self Regulated Thinking process even though there are several indicators that are not met, namely planning other methods to solve problems and not managing time.

Identifying and using the existing learning resources

In the third Self Regulated Thinking (SRT) process, namely identifying and determining the required resources. The S4 recognizes and uses the required resources well. However, the results of observations when working on questions, S4 cheated most of his friends' answers. In the interview process, it was also seen that S4 imitated the answers of previous friends. This means that S4 has not been able to do the third Self Regulated Learning (SRT), which is to recognize and determine what is needed to solve the problem.

Giving a response or feedback

In the fourth Self Regulated Thinking (SRT) process, which is responding to feedback, S4 has been able to do it. S4 stated that he was somewhat sure of the correct answer. The doubts experienced by S4 were caused because he had not mastered the questions correctly. He also often chuckled because he was confused about answering questions from researchers and looked back (S3) to ask what answers he needed to convey. This shows that S4 has not been able to listen to input openly and refutes feedback when S4 feels it is not appropriate.

Evaluating the effectiveness of his own actions

In the last process, Self-Regulated Thinking is evaluating the effectiveness of one's own actions. S4 has no other strategy/method for evaluation material. He also did not re-check the answer. From the description of the results of the analysis, it shows that S4 has not done Self Regulated Thinking (SRT) in solving problems.

Discussion

Based on the description and analysis of students' Self Regulated Thinking data, data were obtained showing that students who succeeded in working on problem-solving-based questions had different thinking sensitivities. Of the five aspects/processes in Self-Regulated Thinking, namely being aware of their thoughts, designing appropriately, recognizing and using the necessary resources, responding to feedback appropriately, and evaluating their actions (Marzano, 1997). Most of them do though with different strategies from each student.

Interviews were conducted on students, showing that students can easily convey the data that is known and what is being asked, even though they do not write down the answer sheet on the answer sheet. Their ability to communicate the answer shows that they understand what the question is asking. The same thing was also conveyed by Sudirman where the students who were able to present known and asked data from the presented problems, showed that the students understood the given problem. (Baeti, 2015).

Students are also able to make or design problem solving plans in their own way. According to Soedjadi (2000), solving math problems requires several steps: revealing what is known, making mathematical models, completing mathematical models, and returning answers to questions. At this stage, students are emphasized to create a mathematical model that fits the given problem. This aspect is the most important step. Because it affects to the next stage. If at this stage it is wrong, then most likely the next step is wrong.

In addition, the process of students' metacognition when answering the questions given was already visible. According to Mohsen Mahdavi (2014) there are 3 stages in metacognition, namely planning, monitoring plans, and conducting evaluations. In the

planning process, students really understand what is known from the problem. Monitoring of their plans is done by including what is known in the completions they write. Students also evaluate very well. At the time of the evaluation they re-checked their answers.

The questions given to the students can motivate students to try to think more than usual and regulate their thinking processes. This is in line with what was conveyed by Frederick who stated that problem solving can increase motivation, because students are faced with challenging and interesting problems.

CONCLUSION

The students who were respondents in this study expressed their self-regulated thinking abilities in almost the same way when faced with a problem. However, there are also students who have not been able to carry out the SRT units in their entirety because the solution he uses is the result of imitating his friend's work. This study shows that the junior high school students in this study already have the maturity of thinking. They already have the skills to monitor their own thoughts, determine appropriate problem solving plans, identify and use existing learning resources, provide responses or feedback, and evaluate the effectiveness of their own actions. Mathematics learning designed should provide space for students to construct their own understanding. Students are given the opportunity to "re-discover" a mathematical concept. Accordingly, the teachers should be able to design the effective learning plan for students by considering students' writing and speaking output. In addition, the teachers have a duty to foster students' self-confidence. This one is needed because it affects the way how the students answer math problems.

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