

Exploration of self-regulated learning: Mathematical problem solving

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Exploration of self-regulated learning: Mathematical problem solving

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Abstract. Self-regulated learning is needed to regulate and direct itself, adjust, and control self-learning. This study aims to get an overview of students' self-regulated learning in solving junior high school mathematics problems. This research is a qualitative descriptive study with three research subjects. The data collection techniques used math ability tests, problem-solving tests, self-regulated learning questionnaires, and interview guidelines. The results showed the profile of self-regulated learning raised by junior high school students when solving math problems, especially problems related to SPLDV, namely: 1) Planning, thinking and activation stages: (understanding the problem is expressed in using one's own language or the language of the problem and there is an estimate of SPLDV completion through arithmetic procedures, logic and elimination substitution methods; 2) Monitoring Stage: monitoring is carried out on the correctness of the variables with or without involving the whole conversation; 3) Control stage: answer checking with reverse technique; and 4) Reaction and Reflection Stage: Explore the difficulties faced related to routine and non-routine problems.

1. Introduction

Students will become independent learners in mathematics when faced with opportunities that provide opportunities for them to express and show their thoughts so that they are meaningful in learning. Independence learning itself will affect the achievement of one's academic progress [1]. Therefore, students can organize and direct their own behavior, so that they are motivated to achieve their learning goals [2]. Students need to master a number of learning strategies that they can apply to become independent learners by considering various contexts and the needs of certain learning situations [3]. However, students do not always use optimal learning strategies during independent learning [4], and may even refuse to change their learning behavior during learning [5].

Self-regulated learning is one that is needed in achieving educational goals and can be used to answer problems related to motivation in learning, strategies in learning and self-regulation in learning [6]. Therefore, independent learning or self-regulated learning in learning is clearly needed by someone [7]. When the learning process is given more autonomous opportunities for students to learn, it will place a high demand on students' self-regulated learning skills [8-11]. In addition, self-regulated learning support must be embedded in the learning environment to stimulate the optimal use of student support [12] and is best implemented in a specific context and not as a form of independent instruction [13].



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Pintrich [14] develops aspects of self-regulated learning into four aspects, namely: 1) cognition, 2) motivation and affection, 3) behavior and 4) context. Context and cognition are aspects of self-regulated learning that include problem solving. Incomplete problem solving abilities will be seen when students solve mathematical problems that cannot review the results of their work [15]. In addition, a good understanding of a problem will dig up information on mathematical problems [16]. Ellison [17] states that problem-solving abilities are an important aspect of independent learning and help move away from teaching that is nurture. Context is an important aspect so that the content of mathematics appears in the form of solving mathematical problems [18].

Another positive thing about self-regulated learning lies in how to determine goals, design, and observe yourself which are the main aspects of one's achievement [19,20]. Based on the results of this study, research on student self-regulated learning has not been implemented in problem solving. On the other hand, we all know the importance of self-regulated learning [3,6] when solving mathematical problems [16,17]. This study aims to provide an overview of students' self-regulated learning in solving math problems.

2. Methods

This research is an explorative research with a qualitative descriptive approach. Merriam states that qualitative research aims to understand one's world and the experience they have [21]. The research took place in a junior high school in Semarang City and implemented at the end of 2019 for 4 months involving 34 students. Data on self-regulated learning students in mathematics problem solving were obtained through test and interview methods. The triangulation used to test the validity of the research results was triangulation method. Student self-regulated learning data obtained through test techniques were compared with data obtained through interviews to obtain consistent data, for further analysis. If the two methods have not obtained consistent data, then the self-regulated learning data is retrieved through a questionnaire method to be compared again with the test result data and interview data. The self-regulated learning questionnaire used was a questionnaire developed by researchers [22]. Data analysis was carried out beforehand collecting data, data reduction, data presentation and finally drawing conclusions and data verification [23].

3. Results and discussion

Student self-regulated learning data were taken using the test method with the following question items, as follows:

- Statement
Statement 1: Six years ago Tina was half of the age of Doni.
Statement 2: This year Doni is 22 years old
Problem: What age will Tina and Doni be in the next three years?
- Question
 - a) What information was obtained from the question?
 - b) What is the problem with this question?
 - c) Complete / work on the problem?
 - d) Is solving a problem like this worth to study? Give the reason.
 - e) Make another example of daily problems that you experience and can be solved with SPLDV?
 - f) List the variables you wrote down, complete with their examples.

Self-regulated learning (SRL) raised by junior high school students when solving math problems, especially problems related to SPLDV, is as follows.

3.1. Stage of planning, thinking and activation

This stage has several processes raised by students, among others, as follows.

- 1) states understanding of the problem. In this process, there are two types of SRL, namely (a) expresses understanding using the same language as the question language; and (b) states understanding using one's own language.
- 2) demonstrates the ability to identify important information. In this process, the type of SRL is also divided into 2, namely: (a) shows the ability to identify important information with a detailed description (according to the questions); and (b) demonstrates the ability to identify information by mentioning the core of the problem.
- 3) shows the ability to estimate completion in writing. In this process, the type of SRL is also divided into 2, namely: (a) does not demonstrate the ability to estimate completion in writing; and (b) demonstrates the ability to estimate completion in writing.
- 4) The last process, which shows the ability to estimate the required procedures, the type of SRL is also divided into 3, namely: (a) by stating the types of arithmetic operations in general (addition, subtraction and division); (b) using reasoning instead of the SPLDV concept; and c) using the substitution method, according to the information provided in the questions.

Discussions related to processes (1) to (3) emerge from Piaget's constructivist theory. In general, students who are successful in the assimilation process will be in type (a), while students who are successful in assimilation and succeed in the equilibration process, can make perfect accommodations. So that this student belongs to the SRL type (b). This statement is supported by Piaget's opinion about the process of assimilation and accommodation in the formation of new knowledge schemes [24,25]. As for process (4), the discussion still comes from Piaget's constructivist theory which states that students who have not been able to carry out the assimilation process will fail to understand the settlement method used. This type of student will be in type (a). Students who are successful in the assimilation process will be in type (b), while students who are successful in assimilation and succeed in the equilibration process, can make perfect accommodations. So that this student belongs to the SRL type (c). This statement is supported by Piaget's opinion about the process of assimilation and accommodation in the formation of new knowledge schemes [24,25]. The results of this study support previous research related to understanding the problem [16] and SRL [6,18].

3.2. Monitoring stage

This stage has several processes raised by students, among others.

- 1) monitoring of the understanding he already has. In this process, there are 3 types of SRL, namely (a) not monitoring their understanding; (b) monitoring the imperfect understanding, only mentioning the variables in general without showing the universe of discussion represented by the variable; and (c) monitoring the understanding that is owned perfectly, namely mentioning the written variables complete with their examples.
- 2) monitoring the problem solving process carried out in the previous stage, there are 2 types of SRL, namely (a) monitoring the problem solving process carried out in the previous stage without explaining the reasons; and (b) monitoring the problem-solving process carried out in the previous stage with appropriate explanations.
- 3) monitoring the implementation of problem solving carried out in the previous stage, there are 3 types of SRL, namely: (a) by providing reasons for choosing an unscientific method; (b) by emphasizing the reasoning method used; and (c) by stating that the choice of substitution method refers to the information provided in the questions.

The discussion emerged from Piaget's constructivist theory which states that students who have not been able to carry out the assimilation process will fail to understand the settlement method used. This type of student will be in type (a). Students who are successful in the assimilation process will be in type (b), while students who are successful in assimilation and succeed in the equilibration process, can make perfect accommodations. So that this student belongs to the SLR type (c). This statement is supported by Piaget's opinion about the process of assimilation and accommodation in the formation

of new knowledge schemes [24,25]. The results of this study support previous research related to understanding problems [16] and SRL [6,18].

3.3. *The control stage*

This stage has several processes raised by students, among others.

- 1) check the answers. In this process, there are 2 types of SRL, namely (a) states that they have checked the answers but without being accompanied by an examination process; and (b) states that they have checked the answers but are accompanied by an examination process through a backward technique.
- 2) adjusts the strategy that is most effective to use, there are 2 types of SRL, namely (a) knows the need to adjust the most effective strategy to use, and understanding that there are other methods that are effective but don't use them; and (b) recognizes the need to adjust the most effective strategies to use and understands other effective methods exist and uses them for problem solving.

In general, students who are successful in the assimilation process will be in type (a), while students who are successful in assimilation and succeed in the equilibration process can make perfect accommodations. So that this student belongs to the SLR type (b). This statement is supported by Piaget's opinion about the process of assimilation and accommodation in the formation of new knowledge schemes [24,25]. The results of this study support previous research related to understanding the problem [16] and SRL [18,6].

3.4. *Reaction and reflection stage*

This stage has several processes raised by students, among others.

- 1) recognize the difficulties at hand. In this process, there are 3 types of SRL, namely (a) not recognizes the difficulties faced; (b) recognizes the difficulties faced, even though they cannot be described; and (c) recognize the difficulties at hand.
- 2) gives an assessment of what has been done, there are 3 types of SRL, namely (a) too confident in giving an assessment of what has been done and even tends to overdo it; (b) be careful in assessing what was done; and (c) provide an assessment of what is done according to the beliefs they have.
- 3) provide reflection on the types of problems that will be difficult to face, and there is only one type of answer, namely students feel they will experience difficulties if they face complex or irregular problems

4. Conclusion

The self-regulated learning (SRL) profile raised by junior high school students when solving math problems, especially problems related to SPLDV, is as follows. 1). **Stage of Planning, thinking and activation**, the types of students SRL, namely: (a) declaring understanding using the same language as the question language **or** expressing understanding using their own language; (b) shows the ability to identify important information with a detailed description (according to the questions) **or** shows the ability to identify information by mentioning the core of the problem; (c) fail to demonstrate ability to estimate completion in writing **or** demonstrate ability to estimate completion in writing; and (d) demonstrate the ability to estimate the required procedure by mentioning the type of arithmetic operations in general (addition, subtraction and division) **or** using reasoning instead of the SPLDV concept or using the substitution method, according to the information provided in the questions; 2). **Monitoring stage**, the type of Students SRL, namely: (a) not monitoring the understanding they have **or** monitoring imperfect understanding, only mentioning the variables in general without showing the universe of conversation represented by these variables **or** monitoring the understanding they already have perfectly, namely mentioning the variables which are written down complete with their examples; (b) monitoring the problem solving process carried out in the previous stage without explaining the reasons **or** monitoring the problem solving process carried out in the previous stage

with an appropriate explanation; (c) monitoring the implementation of problem solving carried out in the previous stage by providing reasons for choosing an unscientific method **or** by reinforcing the method of reasoning used **or** by mentioning the choice of substitution method referring to the information provided in the questions; 3). **The Control stage**, the type of Students SRL, namely: (a) states that they have checked the answers but without the examination process **or** states that they have checked the answers but are accompanied by the examination process through the backward technique; b) recognizes the need to adapt the most effective strategy to use, and understands that other methods are effective but does not use them **or** recognizes the need for adjusting the most effective strategies to use and understands that there are other effective methods and uses them for problem solving; and 4). **Reaction and Reflection stage**, the types of Students SRL, namely: (a) not yet recognizing the difficulties faced **or** recognizing the difficulties faced even though they cannot describe or recognize the difficulties they are facing; (b) overconfidence in giving an assessment of what was done and even tending to be excessive **or** careful in giving an assessment of what was done **or** giving an assessment of what was done according to one's beliefs; and (c) students feel that they will experience difficulties if they face complex or irregular problems.

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