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Exploring Students Computational Thinking based on Self-Regulated Learning in the Solution of Linear Program Problem

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Abstrak

This study aims to analyze the students computational thinking in the solution of the linear program problem based on self-regulated learning. The data were collected by self-regulated learning questionnaire, computational thinking test, and depth interviews. This study was conducted in SMAN 10 Tangerang. Computational thinking in students with high and medium levels of self-regulated learning has no difference. Students still make a solution that is fixated with linear program problem-solving procedures in general, that is using examples, substitution, and elimination. In solving problems, students can reach the stages of decomposition and pattern recognition only. Students still do not evaluate the results of their work. Algorithmic performed is less coherent because the abstraction has not been done. The recommendation for further research is the need for research that can develop student abstraction in solving problems. Besides, there is also a need for research that analyzes the reflective of students in computational thinking when solving problems.

Keywords: Computational Thinking; Linear Program; Self-Regulated Learning, Problem-Solving

INTRODUCTION

The Industrial Revolution 4.0 not only had an impact on the industrial sector of the economy but also had an effect on the education system. This is supported by advances in technology, especially communication science, which then gave birth to a new form without borders. The skills that can support the above are computational thinking. Computational thinking is an important ability of students in the 21st century, because in the process, problem-solving is not only focused on solving the problem but more focused on how to solve it (Masfingatin & Maharani, 2019). This is in accordance with the statement that says that Computational thinking is considered a fundamental skill of children in the 21st century (Barr, Harrison, & Conery, 2011; Orton et al., 2016; Rambally, 2017; Sanford & Naidu, 2016). Computational thinking is problem solving skills incorporating computing knowledge (Jamil, 2017). One critical skill that is often underemphasized in education is computational thinking. Computational thinking and mathematics have a reciprocal relationship, computational used to enrich mathematics and science learning (Maharani, Nusantara, As'ari, & Qohar, 2019). The components of computational thinking consist decomposition, abstraction, generalization, algorithmic, and debugging (Maharani, Kholid, Pradana, & Nusantara, 2019). But in this study, the components are modified into decomposition, pattern recognition, abstraction, and algorithm. That is because the debugging process may not occur in this study. Debugging is usually used

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by computer scientists in creating programs. While the generalization in question is pattern recognition.

Many studies have shown that teachers have a profound effect on student learning (Whittle, Telford, & Benson, 2015) and different teaching strategies will affect student achievement (Schroeder, Scott, Tolson, Huang, & Lee, 2007). In general, educators have divided teaching strategies into two main types, namely, teacher-centered and student-centered. In teacher-centered classes, the teacher introduces specific things that are worth learning, and students are told how to interpret them. That is, students must learn to memorize meanings as dictated by things introduced by the teacher. In student class, students are responsible for finding reasons that they can use to create knowledge and understanding. To teach computational thinking, teachers need a variety of different teaching approaches (Guzdial, 2008). One of the strategy who can used is self-regulated learning.

Computational thinking processes can be viewed as goal-directed processes, it is possible to use self-regulated learning theory as a framework for assessing and enhancing computational thinking (Peters-Burton, Cleary, & Kitsantas, 2015). Self-regulation in learning is a process of asking and answering a series of questions within one's self such as why, where, when, or how learning takes place (Noroozi, Järvelä, & Kirschner, 2019). collaborative learning, computational thinking, educational psychology, and learning analytics presented contributions to self-regulated learning with the goal of stimulating cross-border discussion in the field (Noroozi et al., 2019). Self-regulation behaviours offer new insights into STEM education and self-regulated learning with emerging learning analytics (Zheng et al., 2020). Self-regulated learners manage their learning, engage in more metacognitive monitoring and control, are more intrinsically motivated (Muis, 2008).

Self-regulated learning is not a mental ability such as intelligence or academic ability but a process when a student participates actively in learning both metacognition, motivation, and behavior. A student who has good self-regulated learning will be able to control his thoughts, behavior, and emotions to achieve success in the learning process. In this study, self-regulated learning students include three stages, namely: 1) The planning stage; 2) Implementation phase; 3) Evaluation stage. The novelty of this study is it will analyze the computational thinking in students at the linear program material and it in term of self-regulated learning.

METHOD

The subject in this study are students grade 12 in SMAN 10 Tangerang amount 133 students, from all of the students, there are 6 students only who had meet the criteria of subject, namely 3 students are high level of self-regulated learning and 3 students is middle level of self-regulated learning.

Data collection techniques used in this study were tests, questionnaires, and interviews. The test is used to obtain data about students' computational thinking. The test questions were adapted from the Indonesian Bebras Challenge Book 2017 entitled "*Bahan Belajar Computational Thinking*" and developed with basic competencies and indicators of linear program material. The development is in the form of a grid of questions and can be seen in Table 1 below.

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Table 1. The Indicator of Computational Thinking Test

No.	Indicator	Computational Thinking component	Difficult level
1.	Given a problem regarding making a dress that requires some fabric. Students can determine the amount of fabric used to make dresses.	*Decomposition, Pattern Recognition, Abstraction, Algorithm Design.*	Difficult
2.	Given a problem regarding the route of travel from home to the beach using the bus. The fare of each change of bus is known. Students can determine which route has the minimum fare.	*Decomposition, Pattern Recognition, Abstraction, Algorithm Design.*	Easy

The following is an instrument of computational thinking test used in this study

Mina has a roll of cloth and cuts it so that each fabric produces a piece of fabric with a length of 10 m. Joy wants to make a dress and needs seven pieces of 4m fabric length and seven pieces of 3m fabric. Joy can cut the cloth that Mina has cut according to her needs. Determine:

a. How much fabric can be made from Mina's one piece of fabric?
b. If Mina wants to give Joy a piece of cloth as little as possible. How many pieces of minimal fabric can Joy use to make a dress?

This question used to collect the data regarding students computational thinking skills in solution of linear program problem. Questionnaire used in this study to describe the level of students self-regulated learning. The questionnaire designed by using Likert scale to collect the data regarding the level of students self behaviours in learning process.

An example of a self-regulated learning questionnaire in this study is as follows. "*I am diligent in looking for additional material from the library because of the demands of the teacher's assignment*" and "*If I do not understand about a subject matter subject, I will ask a friend via e-mail*". In addition, data collection is also done by interview, interviews are used to obtain more in-depth data about computational thinking. Interviews were conducted after students worked on computational thinking test questions and that is a semi-structured interview. Examples of interview grille items in this study, namely students' answers about how to break down complex problems into simpler problems.

RESULTS AND DISCUSSION

The self-regulated learning category consists of high and medium categories. Students' answers in completing computational thinking test questions based on the category of self-regulated learning can be seen in Table 2 below.

Table 2. Answer type based on self-regulated learning category

Number of question	Students answer type	Self-regulated learning category		Students	
		Tinggi	Sedang	Tinggi	Sedang
1.	The answer uncomplete	Student reach the pattern recognition component only	Student reach the pattern recognition component only	2	3
	Wrong answer			1	0

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2.	The answer uncomplete	Student reach the pattern recognition component only	Student reach the pattern recognition component only	3	3
	Wrong answer			0	0

Based on the results of the self-regulated learning questionnaire, no subjects with low levels of were obtained self-regulated learning. This shows that the students of SMAN 10 Tangerang City class have relatively good learning independence. However, this good level of self-regulated learning does not lead to levels of computational thinking to different. Both subject's self-regulated learning high and medium are only able to achieve 2 indicators of computational thinking, namely decomposition and pattern recognition. The answer to subjects is self and regulated learning high and moderate can be seen in Figures 2 and 3 as follows:

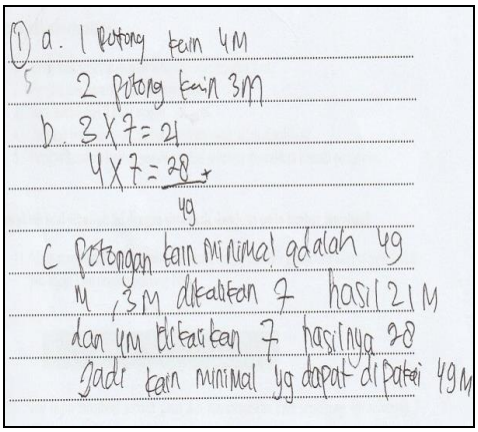

Figure 1. Answer of Subject T1

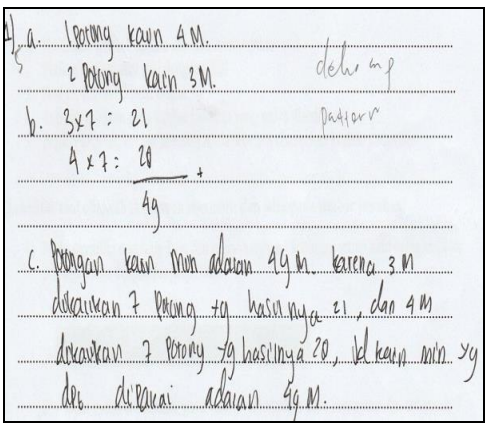

Figure 2. Answer of subject S1

Both subjects have the same answer, both in decomposition and pattern recognition. Subjects T1 and S1 also cannot properly understand the questions in the problem. Seen in answer 1c) the subject is not explaining the stage of completion starting from the initial stage, namely decomposition or decomposition of the problem. However, subjects T1 and S1 only describe the answers to questions 1b). In pattern recognition or pattern making, subjects T1 and S1 also only managed to make one pattern from the problem and represent it verbally. Only T3 subjects make modeling differently, as shown in Figure 4 below:

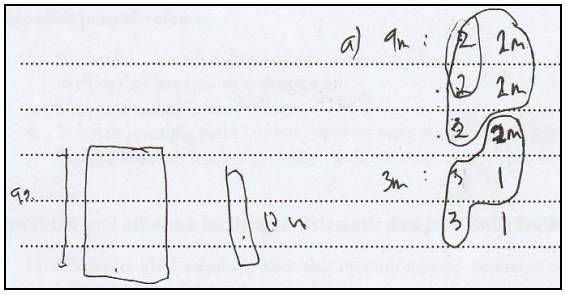

Figure 3. the Answer of Subject T3

Overall, the subject could not reach the indicator abstraction, so the algorithm design that was carried out was not coherent. This can be caused because students are not familiar with computational thinking questions and still do the fixation that is fixated with linear program problem-solving procedures in general, namely using examples, substitution, and elimination. following:

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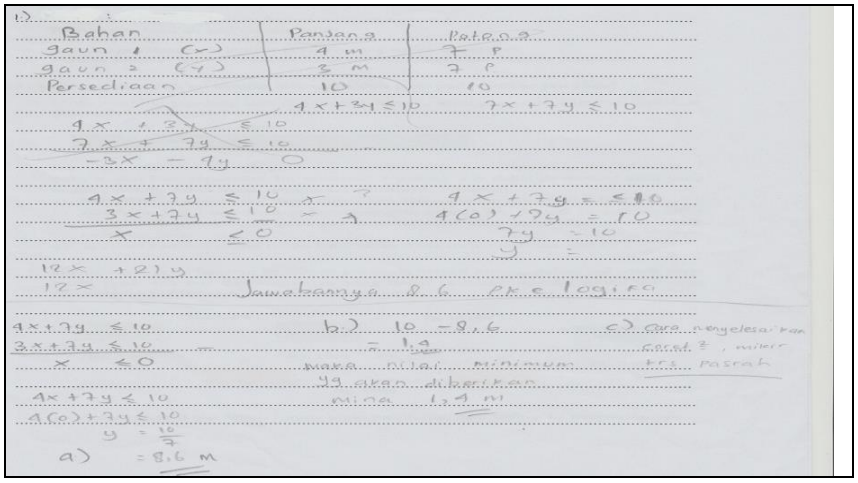

Figure 4. the answer of Subject T2

Students who are still fixated on this one type of settlement can be due to the lack of teachers in providing a variety of questions and solutions. Therefore, teachers need to provide learning with a variety of questions and solutions. Giving a variety of questions and solving this will also be able to help students in solving problems.

Overall, both subjects with self-regulated learning high and moderate, have a low level of evaluation. This is shown from the results of tests computational thinking conducted by students, there are errors/errors of completion in the indicator pattern recognition, but do not review the work results. Thus, the results of this study contradict the Latipah's, (2010) research on "Strategies Self Regulated Learning and achievement: Meta-Analysis Studies" found that there is a positive correlation between strategies self-regulated learning and acceptable learning achievement.

Zamnah (2017) research "The Relationship Between Self-Regulated Learning and Mathematical Problem Solving Ability in Mathematics Subjects for Class VIII of SMP Negeri 3 Cipaku Academic Year 2011/2012" found that there was a significant relationship between self-regulated learning students' and mathematical problem-solving abilities student. However, in this study, researchers found no difference between high self-regulated learning and moderate problem-solving in computational thinking. This can be influenced by the lack of application of computational thinking to learning mathematics in Indonesia.

CONCLUSION

Building students computational thinking is a powerful and necessary component of instruction because it represents a universally applicable skill set. Computational thinking in students with high and medium levels of self-regulated learning basically has no difference. Students still make a solution that is fixated with linear program problem solving procedures in general, that is using examples, substitution, and elimination. In solving problems, students are able to reach the stages of decomposition and pattern recognition only. Students still do not evaluate the results of their work. Algorithmic performed is less coherent because the abstraction has not been done. The recommendation for further research is the need for research that can develop student abstraction in solving problems. In addition, there is also a need for research that analyzes the reflective of students in computational thinking when solving problems.

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