

# Mathematics Literacy of Secondary Students in Solving Simultaneous Linear Equations

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**Abstract.** This study examines the profile of secondary students' mathematical literacy in solving simultaneous linear equations problems in terms of cognitive style of visualizer and verbalizer. This research is a descriptive research with qualitative approach. The subjects in this research consist of one student with cognitive style of visualizer and one student with cognitive style of verbalizer. The main instrument in this research is the researcher herself and supporting instruments are cognitive style tests, mathematics skills tests, problem-solving tests and interview guidelines. Research was begun by determining the cognitive style test and mathematics skill test. The subjects chosen were given problem-solving test about simultaneous linear equations and continued with interview. To ensure the validity of the data, the researcher conducted data triangulation; the steps of data reduction, data presentation, data interpretation, and conclusion drawing. The results show that there is a similarity of visualizer and verbalizer-cognitive style in identifying and understanding the mathematical structure in the process of formulating. There are differences in how to represent problems in the process of implementing, there are differences in designing strategies and in the process of interpreting, and there are differences in explaining the logical reasons.

## 1. Introduction

Literacy has become an interesting debate to national and international countries. Many countries incessantly conduct literacy assessments and look for ways to improve literacy. Mathematic teachers have to realize that in order to face an increasingly developed world, it is necessary for the young generation to be responsive and critical. However, Indonesia in international level is considered unable to contribute a generation that have a good literacy skill. The fact revealed by Wardhani [1] that the learning result assessment instrument designed by secondary teachers in Indonesia in the syllabus development model published by *BSNP* (National Education Standards Agency) [2] generally presents an instrument of learning outcomes with inadequate manner to facilitate students in developing literacy skills which impact on the low achievement of the students in the event of world literacy assessment.

The literacy issues of the PISA and TIMSS (Trends International Mathematics and Science Study) study, which measure international students' math skills and science, require reasoning and problem-solving skills that emphasize issues and situations in everyday life. The ability to think mathematically is an important ability in students that is needed to be developed to deal with problems, both in mathematical problems and problems in real life. Mathematical standards power process according to NCTM [3] includes: problem solving skills, reasoning skills, communications skills, connection skills, and representation skills. Mathematical literacy is an individual's capability to formulate, employ, and interpret mathematics in a number of contexts. It includes mathematical concepts, procedur, facts and tools to describe, explain and predict the phenomena. It assists individuals to recognize the role of OECD



[4]. Lange [5] states that the mathematics literacy is an individual's capacity to identify and understand the role that the human being made, concerned and reflective citizen as well. Mathematical literacy involves seven basic skills that must be had by OECD [6], namely: Communication; Mathematizing; Representation; Reasoning and Argument; Devising Strategies for Solving Problems; Using Symbolic, Formal and Technical Language and Operations; Using Mathematics Tools.

Problem solving is a basic ability that should be mastered by students. According to Polya [7], problem solving is an attempt to find a way out of a difficulty in order to gain a goal that is not immediately achieved. While the steps in the problem solving are: read, explore, select a strategy, solve the problem, review and extend (Carson) [8]. The demand for problem-solving abilities is explicitly defined in a competency-based curriculum, as basic competencies that must be developed and integrated into a number of appropriate materials. The importance of problem solving is asserted in NCTM [3] which states that problem solving is an integral part of mathematics learning, so it should be noticed from mathematics learning.

One of the materials containing mathematical problem solving in junior level is simultaneous linear equations. In this material, students learn about problem solving related to everyday situation, so it requires good representation ability in solving problems. One of the indicators of success or failure in the learning process, both formal and informal is the result of learning. There are various factors influence the learning outcomes; one of which is the cognitive style. Uno [9] stated, cognitive style is a typical way of students in learning, both relating to the way of receiving and processing information, as well as the habits associated with the learning environment. Smith [10] suggested that cognitive styles refer to an individual's preferred way of processing information.

In mathematics, the information presented can be in the form of verbal symbols and visual symbols. Acceptance of information in the form of verbal symbols and visual symbols by students may differ depending on the cognitive style. McEwan [11] stated that the cognitive style associated with a person's habits using his sensory apparatus is divided into two groups, namely the *visualizer* and the *verbalizer*. Kozhevnikov [12] also proposed that the cognitive style is divided into two dimensions: the *visualizer* and the *verbalizer*.

Mendelson [13] explains that individuals who have a cognitive style of *visualizer* tend to be more in the picture, more fluid with illustrations and translations, as well as understand and like more visual games, such as puzzles. While individuals who have a cognitive style of *verbalizer* are more likely to say and would prefer to communicate to someone by showing how they do it.

Based on the background, the questions in this study include: how the profile of secondary students' mathematics literacy cognitive style of *visualizer* in solving simultaneous linear equations and how the profile of secondary students' mathematics literacy cognitive style *verbalizer* in solving simultaneous linear equations.

Based on the research question above, the purpose of this research is as follows: to describe the profile of mathematics literacy of secondary students' of cognitive *visualizer* style in solving the problem of simultaneous linear equations and to describe the profile of mathematics literacy of secondary students' of cognitive *verbalizer* in solving problem of simultaneous linear equations.

The expected benefits of this study are as follows; to provide knowledge and insight to readers, especially mathematics teachers about student's mathematics literacy to optimize students' literacy ability in solving problems based on students' cognitive style and as reference for other researchers about secondary students' mathematical literacy in solving problems in terms of cognitive style of *visualizer* and *verbalizer*.

## 2. Method

### 2.1.Types of research

This research type is descriptive with qualitative approach. This study aims to describe in depth about the profile of students' mathematical literacy in solving the problem of simultaneous linear equations of cognitive style of *visualizer* and *verbalizer*. Therefore this type of research is qualitative research.

### 2.2.Research subject

This research was conducted in SMP (Junior High School) IPH Surabaya city of grade VIII with 27 students. The subject selection process began with the provision of cognitive style test and mathematics skills tests. The selection of students' answers will show students' tendency toward their cognitive style. The cognitive style test is used to determine the subject with the cognitive style of the *visualizer* and the cognitive style of the *verbalizer*. Mathematic skills tests are used to determine students with equal ability. Subjects are also controlled by the same gender; because Kruteski [14] stated that gender have difference output in mathematical. From the test the, the subject obtained was male students. After obtaining the subject, subjects were given problem-solving tests of simultaneous linear equations and interview.

### 2.3. Data, instruments, and data collection techniques

To obtain the necessary data, data collection techniques were used are test and interview. In this study, the test used was the cognitive style test developed by Mendelson & Thorson [15]. Original instruments were written in English, but firstly it has to be translated into Indonesia language. The instrument consisted of 20 questions with 10 questions about the cognitive style of the *verbalizer* and 10 questions about the cognitive style of the *visualizer*. Furthermore, the subjects were given the mathematics skills tests in the form of mathematics national exam which consists of 10 questions of grade seven and eighth, mathematics skills tests is used in taking subject with equal ability. Furthermore, the provision of problem solving tests is prepared to reveal the profile of mathematics literacy of secondary students'. The problem consists of mathematical problem of simultaneous linear equations.

The interview functions as a guide to explore the subject's mathematical literacy and during the research implementation there was no information passed by.

## 3. Results and discussion

Results and discussion obtained by researchers can be stated as follows. Each subject is given a problem-solving problem about simultaneous linear related to everyday life. The simultaneous linear problem is as follows:

Wahyu wants to compose some flat waves arranged in hexagon and rectangle shape by attaching them to a carton. He attaches the hexagon and rectangles from top to bottom (lengthwise) so that one side of the adjacent meets. The first flat build was 21 cm height, composed of three regular hexagons and three rectangles. The second flat height is 19 cm, composed of three regular squares and two rectangles. If the third is arranged from a regular hexagon and two rectangles, determine the high of the third flat, if Wahyu wants to make another flat build that is 30 cm in height, with many regulated order rules and many rectangles one at a time, try to interpret which one is more hexagonal or rectangular? Why? Determine the number of regular and rectangular hexagons!, and whether your answer consistent with your interpretation?

### 3.1. The subject's mathematics literacy profile reviewed from the cognitive styles of visualizer in troubleshooting simultaneous linear equations

In formulating process, student can identify the mathematical aspects which function to determine the important information. Understand the structure of mathematics, identify the information known and asked in full and pay attention to the build order of the problem. In representing the problem differently, presents all information in the form of an image as shown in figure 1.

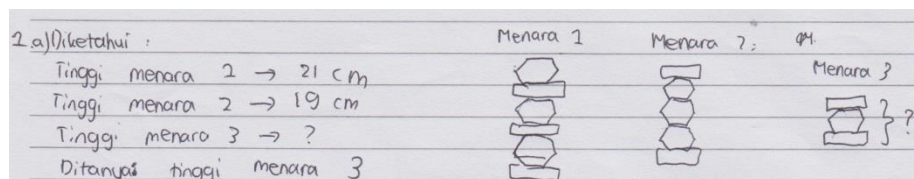


Figure 1. Student's Answer

In implementing process student is able to formulate a strategy to find a solution that is by using the elimination method. In applying mathematical rules and structures when searching for solutions, the subject began to define variables by modelling, forming mathematical models and simplifying mathematical models. In using various situations in the process of finding solutions, student simplifies the mathematical equations by eliminating variables with the same coefficients as shown in figure 2.

Jawab :

$$210 = 3x + 3y$$

$$19 = 3x + 2y$$

$$2 = y$$

$$21 = 3x + 6$$

$$15 = 3x$$

$$x = 5$$

Tinggi menara 3  $\rightarrow$   $5 + 4 = 9$  cm

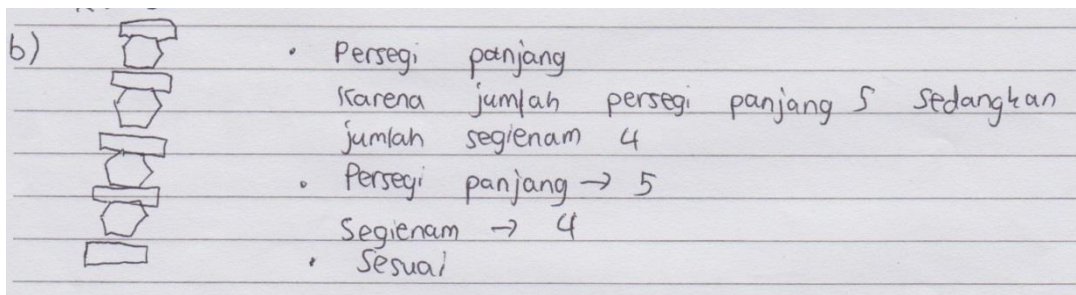
**Figure 2.** Student's Answer

In interpreting process student is able to re-interpret mathematical results into a real problems. In explaining and evaluating the plausible reasons of a mathematical solution into a real problem, student is unable to give logical reasons, to make limited on trial and connect with the terms given.

### 3.2. The subject's mathematics literacy profile reviewed from the cognitive styles of verbalizer in trouble-shooting simultaneous linear equations

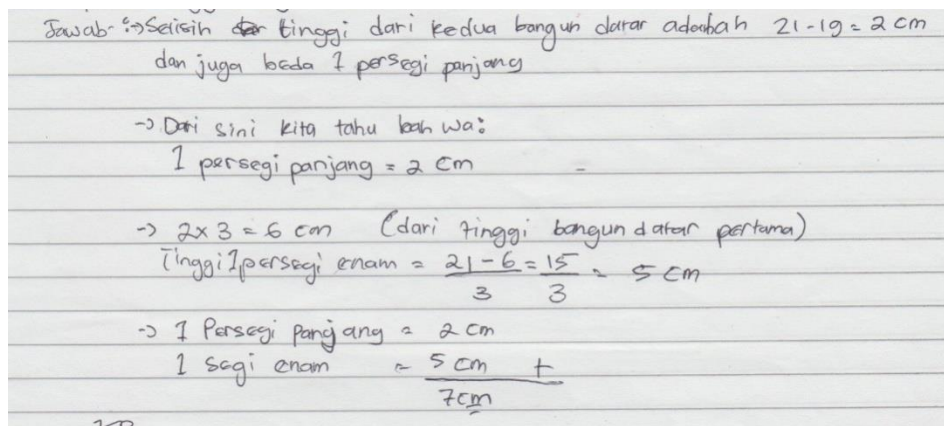
In formulating process, student is able to identify the mathematical aspects by mentioning the information that is considered important. In understanding the mathematical structure, student mentions information about what is asked and what is not known in detail. In presenting the information in its own language the problem is not sorted. Student pays more attention to information in the form of a sentence from the problem, to get the pattern when starting to read the problem.

1. Diketahui :  $\rightarrow$  Tinggi bangun datar pertama = 210 cm  
 $\rightarrow$  Tinggi bangun datar kedua = 19 cm  
 $\rightarrow$  Bangun datar pertama tersusun dari : 3 buah segitiam dan 3 buah persegi panjang  
 $\rightarrow$  Bangun datar kedua tersusun dari : 3 buah segieram dan 2 buah persegi panjang



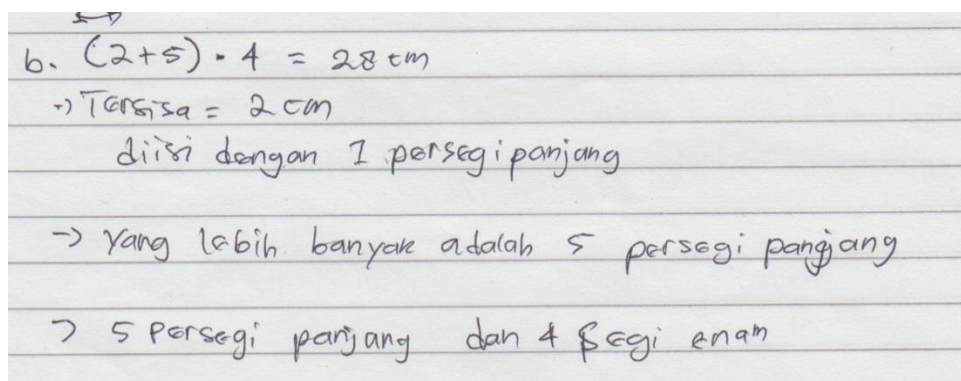
**Figure 3.** Student's Answer

In applying process, student devises strategy to find solution using the logic mathematical thinking from the pattern that has been acquired. In applying facts, rules and mathematical structures when looking for solutions student was able to connect information to form a pattern. In using various situations in the process of finding solutions, student use algebraic operations.



**Figure 4.** Student's Answer

In interpreting process, student was able to re-interpret mathematics into real problems by looking at the patterns of types of numbers that represent the height of each two-dimensional figure, i.e. even and odd number. In explaining the plausible reasons of the mathematical solution into the real world the subject is able to provide a reasonable excuse as shown in figure 5. In explaining why mathematical results are appropriate or not with the problem, the subject used algebraic operations and mathematical thinking logic in proving.



**Figure 5.** Student's Answer

### 3.3. Similarities and differences of subjects' literacy profile viewed from cognitive styles of visualizer and verbalizer in trouble-shooting simultaneous linear equations

#### 3.3.1. Similarities of mathematical literacy profiles in solving simultaneous linear equations problems of visualizer and verbalizer subjects

The process of formulating is used to identify the mathematical aspects of both subjects as well as declared the same information about the important information of the question. Both subjects were also able to understand every sentence of the question. In understanding the mathematical structure, both subjects wrote things known and asked in the same way. Both subjects also stated the same about what to be found out to solve the problem. In representing the problem in different ways, both subjects were able to retell the problem without reading the problem even in different words. In the process of application, finding the second solution, the subjects used the previous information by substituting the value obtained on the information.

#### 3.3.2. Differences of mathematical literacy profiles in solving simultaneous linear equations problems of visualizer and verbalizer subjects

The following is the table of differences in the mathematical literacy profile in solving the simultaneous linear equations problem of *visualizer* and the *verbalizer* subjects.

**Table 1.** The differentiation of Mathematical Literacy Profiles in Solving Simultaneous Linear Equations Problems which is done by *Visualizer* and *Verbalizer* Subjects.

Mathematical Literacy	Visualizer Subject	Verbalizer Subject
Formulating	Paying attention to the arrangement of the dimensional figure, presenting information in the form of images, presenting information with the own language, stating known first and then asked, insequence and complete.	Not paying attention to the structure of the building, presenting information in written form, presenting information in own language randomly, declaring asked first and then known but not completely (some information were not mentioned).
Application	Presenting information in the form of mathematical equations by forming coefficients and variables, simplifying the mathematical equations by using elimination.	Presenting information with patterns found from the scratch, using the difference to solve math problems.
Interpretation	Trying to interpret the answer until the answer is obtained in accordance with the conditions given.	Using reason in interpreting the answer according to the conditions given.

## 4. Conclusions

Profile of mathematical literacy in solving simultaneous linear equations problems subject with the cognitive style of *visualizer* and *verbalizer* have similarities in identifying and understanding the mathematical structure in formalization process. There are differences in representing the problem, in applying process implies, in designing strategies, in the process of interpreting, and in explaining the logical reasons.

## 5. Suggestion

Teachers need to pay more attention to the cognitive style of the students in carrying out learning activities by using appropriate approach or strategy related to the learning material.

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