Representation of Students in Solving Simultaneous Linear Equation Problems Based on Multiple Intelligence

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Abstract. This study described representation of students who have musical, logical-mathematic and naturalist intelligence in solving a problem. Subjects were selected on the basis of multiple intelligence tests (TPM) consists of 108 statements, with 102 statements adopted from Chislet and Chapman and 6 statements equal to eksistensial intelligences. Data were analyzed based on problem-solving tests (TPM) and interviewing. See the validity of the data then problem-solving tests (TPM) and interviewing is given twice with an analyzed using the representation indikator and the problem solving step. The results showed that: the stage of presenting information known, stage of devising a plan, and stage of carrying out the plan those three subjects were using same form of representation. While he stage of presenting information asked and stage of looking back, subject of logical-mathematic was using different forms of representation with subjects of musical and naturalist intelligence. From this research is expected to provide input to the teacher in determining the learning strategy that will be used by considering the representation of students with the basis of multiple intelligences.

1. Introduction
Representation is a mental picture of a person in solving problems and visualized in verbal, simbolic, or visual form. Representation is a configuration that can represent something else in some manner [1].

Definition of three distinct ways in which people represent the world: (a) through action, (b) through visual images, and (c) through words and language [2]. Representation was categorized in two types namely internal and external representation, internal representation is the process of thinking about mathematical idea that allows one's mind to work on the idea [3]. While external representation is the ability to pour thought in the form of verbal, symbol, visual. The ability to solve mathematical problems depends on one's ability to construct and use mathematical representation in words, graphs, tables, equations, and symbol manipulations [4]. So a complicated problem can be simple if using proper troubleshooting. Multiple intelligences relate to the process of thinking someone to solve the problems faced [5]. Multiple intelligence is the ability to solve problems or create valuable products in one or several cultural and community environments [6].

Based on the observations of researchers during teaching, the process of learning in schools so far students are rarely even never given the opportunity to pour his own representation. Most students simply imitate the teacher's way of solving the problem as a result of the not developing student representation [7]. In addition, students have difficulty in solving the material story of the system of
two-linear equation system including difficulties in determining initial conditions, determining equations, solving equations, and translating answer [8]. So in this study is expected that students with mature intelligence is capable of solving problems logically and systematically and has many ways used in problem solving.

This research is descriptive research with qualitative approach. The purpose of this study is to describe representation of students who have musical, logical-mathematic and naturalist intelligence in simultaneous linear equations problem solving. Subjects were selected on the basis of multiple intelligence tests, and selected one subject from each musical, logical-mathematic and naturalist intelligence. The selected subject was given problem solving and continued with the interview. The results show the stage of presenting given information, the stage of devising a plan, and the stage of carrying out the plan and the three subjects using symbolic representation. While the stages of presenting information and the stage of looking back, the subject of logical-mathematic intelligence is using symbolic representation subjects of musical and naturalist intelligence using verbal repression. By this research result, teacher can be expected to determine learning strategy that will be applied by considering representation of student with base of multiple intelligence owned by student.

2. Context and Review of Literature

2.1. Representation

Many experts who define representation said that representation is the ability of students to communicate mathematical ideas/ideas learned in a particular way [8]. Everything students create to externalize and display works is called representation [9]. Three different ways of representing a person are through action, through visual images, and through words [9].

Four basic ideas were used in understanding the concept of representation, namely (a) representation can be viewed as an internal abstraction of Mathematical ideas or cognitive schemes constructed by students through experience, (b) as mental reproduction of the previous mental state, (c) as structurally presented through images, symbols or symbols, (d) as knowledge of something that represents something another [10]. "representations are used by students to think and communicate mathematical ideas" [11]. Representations that are often used in communicating mathematical ideas are diagrams, tables, mathematical statements, written texts or a combination of them all.

Representation is divided into two namely internal and external representations. The internal representation of a person is difficult to observe directly because it is a mental activity of a person in his mind (minds-on). But the internal representation of a person can be inferred or suspected based on external representations in various conditions, for example from the expression through words (spoken), through writing in the form of symbols, drawings, graphs, tables or through a hand-on [12]. So that internal and external representations influence each other in the process of making a simple picture or in expressing mathematical ideas.

Based on the above description, the representation in this study is a mental picture of a person in solving the problem and visualized in the form of verbal, symbol, visual. Verbal forms include words or sentences either written or spoken. Symbol forms include the way of writing in algebraic manipulations and equations. While the visual form includes cartesian and table charts.

2.2. Mathematical Problem Solving

Problem solving is a process or individual effort to respond or overcome obstacles or constraints when an answer or answer method has not been apparent [13]. "Solving a problem is finding the unknown means to a distinctly conceived end" (problem solving is an attempt to find something that is not yet known in a suitable way) [14]. Mathematical problem solving is a complex cognitive activity accompanied by a number of processes and strategies [15]. Based on some opinions then understanding problem solving, then problem solving in this research is an effort done by someone (student) to get correct solution of problem faced by using knowledge, skill and comprehension gained before.
The troubleshooting steps used in this research are the troubleshooting steps of Polya. The researcher chooses the polya problem-solving steps because the problem-solving stages proposed are quite simple, and the differences in activities at each stage are clear enough. Here are the steps to solve the problem:

(a) Understanding the problem, this stage the students try to understand the problem clearly. By understanding the problem then the student can know what steps will be used to solve the problem at hand. Students should also be able to show what is known and what is being asked. (b) Devising a plan, making the completion plan is not easy, but by collecting information ever received by students. At this stage students need to look at the interrelationships between questions and solutions to be presented, as well as the appropriate ideas or strategies for solving the problems they are facing. (c) carrying out the plan, the students implement the plan already made. The ideas that have been planned will be applied to find solutions from problem solving which are then repressed with tables, words, graphics, or mathematical symbols. (d) looking back, students re-examine the results of the problem solving that has been done. This check is done to decide that the answer is already logical and in accordance with the issues presented.

2.3. Multiple Intelligence

Intelligence has more to do with the capacity for solving problems and fashioning products in a context rich and naturalistic setting [6]. It defines intelligence as the ability to solve problems or create valuable products in one or several cultural and community environments. Intelligence is the ability to learn from experience and to adapt [5]. Based on the above opinion so it is concluded that intelligence is the ability of a person (student) to solve problems or create a valuable product by learning from experience and to adapt. So that intelligence relates to the process of thinking someone to solve the problems encountered.

Gardner defines nine intelligences, namely Linguistic Intelligence, Logical-Mathematic Intelligence, Visual-Spatial Intelligence, Body Kinesthetic Intelligence, Musical Intelligence, Interpersonal Intelligence, Intelligence Intelligence, Naturalist Intelligence, and Existential Intelligence. Walter McKenzie classifies nine intelligences in three domains: interactive, analytic, and introspective [16]. Domain used in this research is analytic domain consists of musical intelligence, logic-mathematics, and natural, which is used to analyze data and knowledge. Intelligence in the analytics domain can have social or introspective components and can be used to analyze data and knowledge and incorporate data in existing schemes. This domain is basically a natural hauristic process.

2.4. Relationship between representation and problem solving based on multiple intelligence

When students construct the correct representation with the problem will be getting the right solution [17]. So in doing problem solving, it takes a person's ability to give consideration to the form of representation involved. It shows that a person's ability to change a representation will affect his or her skills in finding problem-solving solutions. So a complicated problem can be simple if using proper troubleshooting. The representation indicators in solving simultaneous linear equations are shown in Table 1.

| Problems Solving Steps | Representation | Indicator |
|------------------------|---------------|----------|
| Understanding problem  | Verbal        | Present data or information back to the written text. |
|                        | Simbol        | Representing data or information on the question of algebraic manipulation. |
|                        | Visual        | Representing data or information on the matter of a table. |
|                        | Verbal        | Develop problem-solving strategies using words. |
| Divising a plan         | Simbol        | Develop a troubleshooting strategy that will be pursued based on information on the problem. |
|                        | Visual        | Develop a troubleshooting strategy using tables. |
Problems Solving Steps | Representation | Indicator |
---|---|---|
Carrying out the plan | Verbal | Complete the model that has been formulated in the previous step by using written words or text. |
| Simbol | Completed the model that has been formulated in the previous step that contains symbols and mathematical formulas according to formal rules. |
| Visual | Complete the model that has been formulated in the previous step using the graph. |
Looking back | Verbal | Check the results again and summarize the answers obtained in accordance with the question on the problem. |
| Simbol | Check back the troubleshooting strategy and recalculate to prove that the answers obtained are correct. |
| Visual | Summarizes the answers obtained according to the questions on the problem. |

3. Method
The study was conducted on senior high school students in Manyar Gresik Indonesia, with 84 participants and selected 3 students with each subject at different intelligences at musical, logical-mathematical and naturalist intelligence. The subject selection process by means of a multiple intelligence test (TKM) and selected subject with the highest intelligences score from musical, logical-mathematical and naturalist intelligence. Subjects who meet the problem criteria are given the problem-solving simultaneous linear equations problem solving (TPM) and interviewing. The data validation uses triangulation time, so that subjects are given TPM and interviewing twice in different time and with equivalent problem. The data obtained in the analysis using representation indicators with the problem solving step. If data from TPM 1 and interviewing valid with data from TPM 2 and interviewing then the data can be used, but if the data is not valid then in the TPM and interviewing again until the data is valid.

4. Result and Discussion
The selected subject is given a problem-solving question twice in a different time, with each question consisting of one question item. After that the subject in the interview to dig up the information is not revealed on the answer sheet. Results of student work with analyzed using indicator in Table 1.

4.1. Representation Student of musical intelligence
The results showed the subject of musical intelligence (SMI) solve the problem by using four stages Polya. At the stage of understanding the problem of presenting information that is known by making permisalan then create a mathematical model (equation) and present the information asked by using the written text. At the stage of designing the settlement plan is able to explain the problem-solving plan using words, devise a problem-solving strategy that will be pursued based on the information on the problem. At the stage of carrying out the settlement plan using the substitution method, while at the re-check stage substituting the results of his work to one equation obtained from the problem, without checking again the steps of completion that have been done.

4.2. Student of logical-mathematical intelligence
The results show the subject of logical-mathematical intelligence (SLI) solve the problem by using four stages Polya. SLI presents information that is known by making permisalan then create a mathematical model (equation), presenting the information asked in the form of symbol representation in accordance with the permisalan that has been made. In the stage of designing a settlement plan use your own words and write down each step of the problem. At the stage of implementing the settlement plan using symbol representation, ie in solving the problem using the substitution method. In the re-examination phase, check the completion steps that have been done, then check the results of the answers with the
substitution of answers obtained to one equation and SLI write a conclusion in the form of a sentence to clarify what answers were asked on the issue.

4.3. Student of naturalist intelligence
The results showed that the subject of natural intelligence (SNI) was able to solve the problem well. At the stage of understanding the problem of presenting information that is known in the form of symbol representation by making permissalan then create a mathematical model and present the information asked in the form of verbal representation that is by using written text. SNI explains problem-solving plans using words, as well as solving problems using substitution methods by utilizing the equations already obtained from the problem. In the process of re-examining the SNI substitute value of variables that have been obtained previously to one of the equations obtained from the problem, without checking again the steps of completion that have been done later in writing conclusions in the form of a sentence to clarify the answer to what was asked on the problem.

5. Conclusion and Suggestion
The results show that within the stage of presenting given information, devising a plan, and carrying out the plan, the three subjects using symbolic representation. But at the step of presenting the information, SMI and SNI using representation in verbal form that is by using written text, while SLI use representation in symbol form, according to the example that has been made. In the re-checking stage, SMI and SNI substituted the results of their work to one equation derived from the problem, without re-examining the completion steps that have been done, while the SLI uses representation in the form of symbols, namely by checking back the problem-solving strategies that have been done and Recalculate and by substituting the results of his work into one equation derived from the problem.

For Math teachers subjects are expected to be able to design the right learning strategy so that it can facilitate all plural intelligence especially on SPLDV material learning. So that all students with various kinds of multiple intelligences have good representation. Therefore it is expected that the subject Teachers evaluate the learning process and the way students represent the problem solving.

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