The Profile of Students’ Mathematical Problem Solving on the Topic of Two-Variable Linear Equation Systems Based on Thinking Styles

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Abstract. The study aimed to describe the profile of problem solving grade VIII students at MTs Al-Murahmah, based on thinking styles. The results of the research show the profile of mathematics problem solving of; 1) concrete sequential student are: a) understanding mathematics problems, that tended to organize facts, b) conducting problem solving, that tended to work algorithmically in each stage problem solving; 2) abstract sequential students are: a) understanding the problems, which had tendency to process information abstractly, b) planning problem solving, namely the ability to analyze and present fact in form of mathematics symbol, c) conducting problem solving systematically and linear pattern, 3) concrete random student are: a) tended to be consistent in using guessing strategy or trial and error in solving mathematics problem, b) tended to use formulating pattern strategy by building solving pattern according to the way of thinking; 4) abstract random student are: a) tended to use guessing strategy or trial and error in solving mathematics problem, b) tended to show the basic difference in processing information received.

1. Introduction
Mathematics is the science, that underlies the universal development of modern technology. It has a significant roles in a variety of disciplines and advancing the power of human thought [1,2]. To master the technology and to create it the future, one requires a mastery in math at early level of schools. Mastery in mathematics means comprehending mathematical concepts, developing mathematical reasoning, and capabilities to solve math problems, enveloping mathematical communications skills, and an attitude to appreciate mathematics itself.

Anthony F Gregorc developed an approach in recognizing his thinking style. This model provides insight into how the mind of the individual, dominated the individual viewpoints and how these individual set up the information, poured in the style of thinking. Gregorc itself classifies the thinking styles into 4 categories, namely: concrete-sequential, sequential-abstract, random-concrete and random-abstract. The four thinking styles are owned by each student but there are more comfortable using one of them. DePorter and Hernacki [3] confirmed that each type of style of thinking no better or worse than others. Type the different thinking styles, however, affect a person's success in determining steps to achieve his or her goals. Thinking can also be seen as processing information from existing stimulus, to problem solving or goal state [4].

Anderson & Krathwohl troubleshooting is a complex mental processes, which involve the visualization, imagination, abstractions, and the associated information. Therefore, solving problems
through a process of learning math can help students improve and develop their abilities in the aspect of application, analysis, synthesis, and evaluation [5].

Amri [6] explained that the requirement of students in problem-solving, (1) the prerequisites to tackle such problem; (2) the problem solving itself, (3) a matter of affordability, (4) students are willing and intend to solve the problem.

Mayer (in [7,8]) that: thinking is the cognitive activity happening in someone's mind, mental or not visible, but can be inferred on the basis problems. Thinking arises because there is something thought, desire against that particular motivator or dissatisfaction toward something happening in people's lives. Thinking is always related to the issue to search for the way out.

There are two rules, that will bring someone to the problem solving, namely the rule algorithm and holistic. The algorithm is an order and if this rule is followed correctly there will be a guarantee against problem solving. The general strategy is holistic in the face of a problem, namely that those problems be analyzed or broken down into issues that are smaller, each leading to or close to the solution. This is in line with the opinion and De Porter Hernacki [3] stated that much activity in random thinkers tend to be holistic and creative. In short, random thinkers tend to lead to a way of thinking spreads (divergent thinking). Each category thinking styles in problem solving have their respective characteristics as expressed in earlier.

2. Research Methodology

The Research was a qualitative one, that conducted in four different thinking styles of the subjects. This research was carried out on grade VIII students of MTs Al Murahamah Bantaeng, South Sulawesi Indonesia. There were four subjects of study in different thinking styles, sequential concrete (SK), sequential abstract (SA), random concrete (AK), and random abstract (AA). The subjects were chosen through and according to their Thinking Style Test. The prospective subjects were elected as subjects of research, can be seen in Table 1 below.

| Students/Subjects | Thinking Styles |
|-------------------|-----------------|
| MI                | SK              |
| ER                | SA              |
| SU                | AK              |
| AI                | AA              |

2.1. Research Instruments

The instruments, used to collect data in this study were the researchers as the main instrument, and some other supporting instruments, i.e. thinking styles test to categorize thinking style, as well as a test of math problems and interview schedule to know the profile of the problem solving of students.

2.2. Research Procedure

The research procedure can be explained as follow; 1) the planning phase was done by preparing the instruments, expert judgment, and analyzing and revising the results from the validators. 2) Research implementation was done by giving Test Thinking Styles, and the mathematical problem solving test, specify the appropriate subjects category, interview triangulation at a different time to the subject along with the interview. 3) Data analysis performed with the reduction, exposure, and withdrawal conclusions. 4) Making conclusion.

3. Research Finding And Discussions

3.1. Subject SK

The exposure of research results, mathematics problems regarding with subject SK.
Table 2. Comparison Data TPMM (Problem Solving Math Test) and interviews analysis.

| TPMM                                      | Interview                                           |
|-------------------------------------------|-----------------------------------------------------|
| 1) write down the known elements in the problem (SK-TPM-01) | 1) mention the known elements in the problems (SK-03) |
| 2) read the information, asked for the problem (SK-TPM-01) | 2) mention the information, asked for in the problem (SK-05) |
| 3) make suppose (SK-TPM-03)               | 3) describe mathematical model (SK-06)               |
| 4) add and subtract certain coefficients (SK-TPM-09)         | 4) perform subtraction (SK-41; SK-43; SK-44)         |

3.2. Subject SA
The exposure of research for the results subject SA regarding math problems.

Table 3. Comparison between Interview and TPMM for subject with abstract sequential style.

| TPMM                                      | Interview                                           |
|-------------------------------------------|-----------------------------------------------------|
| 1) get the variable y by dividing (SA-TPM-08) | 1) mention the process of Division (SA-16; SA-17) |
| 2) do elimination (SA-TPM-09)             | 2) do elimination (S-18)                            |
| 3) use multiplication and elimination for variable y (S-TPM-10) | 3) mention multiplication and elimination for variable y (SA-19; SA-30; SA-31) |
| 4) get the variable x by dividing (SA-TPM-11) | 4) describe how to obtain the variable x (SA-35) |
| 5) read the four alternative answers - (SA-TPM-13) | 5) describe four alternative answers- (S-41) |

3.3. Subject AK
The exposure of research results, math problems for subject AK.

Table 4. Comparison between Interview and TPMM for the subject with concrete random style.

| TPMM                                      | Interview                                           |
|-------------------------------------------|-----------------------------------------------------|
| 1) use elimination (AK-TPM-01)            | 1) use elimination and substitution (AK-11)         |
| 2) use multiplication for equations 1 (AK-TPM-1) | 2) mention multiplication and elimination for variable x (AK-14; AK-17; AK-18; AK-19; AK-10) |
| Do the subtraction to equations 1 (AK-TPM-03) | 3) Mention a reduction (AK-11; AK-14)               |
| 3) Add and subtract certain coefficient (AK-TPM-06) | 4) Explain reductions (AK-31; AK-33)                |
| 4) Perform Division by the coefficient x (AK-TPM-07) | 5) Describe how to obtain the variable x (AK-34; AK-35; The AK-37; AK-38) |

3.3.1. Subject AA
The exposure of research results of math problems for subject AA.

Table 5. Comparison between Interview and TPMM subject with random abstract style.

| TPMM                                      | Interview                                           |
|-------------------------------------------|-----------------------------------------------------|
| 1) Use elimination (AA-TPM-01)            | 1) Use elimination and substitution (AA-31)         |
| 2) Use multiplication for equations 1 (AA-TPM-1) | 2) Mention the multiplication for equation 1 to eliminate the variable x (AA-18; AA-19; AA-10) |
| 3) Do the subtraction (AA-TPM-03)         | 3) Mention a reduction to the equations 1 (AA-15; AA-16) |
| 4) Substitution method used to obtain other unknown variables (AA-TPM-05) | 4) Explain reductions (AA-41; AA-43)                |
| 5) Perform Division by the coefficient x(AA-TPM-07) |  }
4. Discussions
Subject of Concrete Sequential (SK) tends to organize the facts, obtained systematically and present the information in a whole range from things, that are unknown until he/she asked. This funding is in accordance with Gregorc [3], which he said that students with concrete sequential thinking styles (SK) tend to use the left brain and process the information on a regular basis. A similar case is also demonstrated by sequential concrete subject (SK) in planning issues. The subjects tends to use inductive mindset, which is in line with the results of the research conducted by Angraeni [9], that she said that one of the characteristics of the subject concrete sequential(SK) is patterned think inductively. Subject concrete sequential (SK) also tend to work in algorithmic. According to Angraeni [9] one of the characteristics of the subject concrete sequential (SK) was an algorithmic problem solving at every step. It is also relevant to Zhu’s opinion [10].

Subject of the abstract sequential (SA), has a tendency to cultivate information abstractly and manage such information regularly. This is in accordance with the opinion of [11] and Gregorc [3], which he said that the abstract sequential thinkers (SA) is the abstract thinker and love events that are organised neatly. The subject of the abstract sequential also tends to analyze and present the facts in the form of mathematical symbols. This is in line with the results of research conducted by Angraeni [9] that she said that the subject of the abstract sequential (SA) produce an abstract form of the situation and a matter into mathematical models. Similarly, on the settlement issue, the subject tends to be systematically led to the strategy of the algorithm.

Subject of concrete random (AK) tends to use strategy to guess or dabble (trial and error). This is in accordance with Gregorc's opinion [3] which he said that random abstract thinkers want to do trial and error approach, therefore concrete random (AK) often do the intuitive leap, that is necessary for creative thinking.

According to Gregorc [3] concrete random subject (AK) using a trial and error approach in solving problems, but on the results of this study show that the subject of random abstract (AA) also use the trial and error approach in resolving problems. As Upu, Djadir & Asyari said [1] that for subject with low and moderate ability mathematics not finding regularity, relationship and patterns related to problems. A similar case also happened on the results of previous studies conducted by Angraeni [9] that the subject of random abstract (AA) in complete problems, tend to use the strategy of forming a pattern of settlement in accordance with the way of thinking, but on the results of this research, it is thus carried out by the subject concrete random (AK).

The subject SA also tend to be better at working on a matter or issue that was given at the time of the process of learning. In addition, to subject SA, the subject of AA also has better math skills from the topic and the subject of SK and AK.

The subject of the SK more active in questioning topics of mathematics, when the learning process takes place. This is done because the subject of the SK less familiar with the topic, so that the explanation given SK actively trying to find out things that have yet to understand. The same is also experienced by the subject of the AK are active in questioning mathematics problems.

Subject SA and AA tend to be savvy against the teacher though the second subject is also sometimes still questions things, that still less understand. But, the subject SA and AA more quickly master the given problems, compared to the subject of SK and AK. This is in accordance with Suradi [12], which he said that the student had concrete sequential thinking styles of their influential trend negatively to the achievement of their learning in mathematics. As for the random thinking style students abstract style, he thinks positive effect towards the achievement of their learning.

The average subject tend to be less able to resolve the problem or issue that is not in accordance with the sample questions provided in advance [13].

5. Conclusion
1. Profile of the math problem solving of students with a sequential concrete thinking style is, in understanding math problems, they were likely to organize the facts obtained systematically, delivered straightforwardly, tend to use inductive basis mindset, and performed troubleshooting.

2. Profile of the math problem solving of students, who have a sequential type of abstract thinking. Style is in understanding math problems, had a tendency to cultivate and manage information abstractly and information obtained on a regular basis, plan a work around that is the ability to analyse, presented the facts in the form of mathematical symbols.

3. Profile of the math problem solving of students, who have a random type concrete thinking style is, in completing math problem, tend to consistently use the strategies of guessing or dabble.

4. Profile of the math problem solving of students, who have a random type of abstract thinking style is in completing math problems, tend to use strategy to guess or dabble, and indicate fundamental differences in processing the information.

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