The Effect Mathematics Disposition of Vocational High School Students on Mathematical Problem-Solving Ability

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Abstract. Problem-solving ability is a basic skill of the 21st century. The problem-solving ability of each individual is not only about the result assessed but also their attitude in the problem-solving process. The attitude here is a mathematical disposition. This research used descriptive qualitative analysis to determine and describe the extent to which the indicators of mathematical problem-solving abilities have been achieved and to determine the level of the students’ mathematical disposition categories. Sampling was conducted by utilizing purposive sampling technique and obtained three subjects from the eleventh-grade students of SMK Muhammadiyah Salatiga. There were two instruments used in this research there are a mathematical problem-solving ability test and a mathematical disposition questionnaire. The validity of the data used was the data triangulation method. Results showed that student in the high mathematical disposition category is able to carry out all of Polya's problem-solving stages. Student in the moderate mathematical disposition category can carry out the stages of understanding the problem, devising the problem-solving plan and carrying out the plan. In addition, student in the low mathematical disposition category can carry out the stage of understanding the problem.

1. Introduction

Any individual, to survive in an increasingly advanced world and face the progress of the 21st century, needs to have skills such as problem-solving creativity, metacognitive innovation, communication and so on. Problem solving ability is one of the most fundamental human cognitive processes [1]. Problem solving is one of the abilities that students need to master after learning mathematics. Increasing students’ ability to solve problems is an important goal of teaching mathematics from various stages of education [2]. It is because problem solving can enable students to improve higher thinking skills and positive attitudes [3].

It is necessary for students to have problem-solving abilities because it is the general goal of teaching mathematics which includes methods, procedures, and strategies. These three are the core and main processes in the mathematics curriculum. Importantly, problem-solving is a basic skill in learning mathematics [4]. Moreover, mathematical ability is also a very important factor for the cognitive development of students and greatly influences learning outcomes [5]. Problem-solving skills are not
only important for those who will deepen or study mathematics further in the future but also for those who will apply it in other fields and in everyday life [6].

There are basically many methods or stages that can be used as a basis for solving problems, one of which is Polya’s problem-solving technique. It includes understanding the problem, devising the problem-solving plan, carrying out the problem-solving plan, and looking back (rechecking). The stage of understanding the problem in this study is a stage where individuals are able to understand what is meant by the questions. An indicator of understanding a problem is being able to determine what is known and asked. The stage of devising the problem-solving plan requires a strong understanding of the concept of the material since it will influence the decision to determine the problem-solving plan. The stage of carrying out the problem-solving plan is an advanced stage from the previous stage. At this stage, the problem-solving experience plays an important role considering that the plans that have been drawn up previously will be continued based on the solutions given. The last stage is the stage of looking back or rechecking the answers. The ability at this stage is achieved when students do a recalculation to make sure or check that the answer is correct. Each student’s, has a different problem-solving process. In this case, there is mathematical disposition: the process of how students solve problems in doing math tasks with confidence, the desire to find alternatives, persistence and interest, and the tendency to reflect on their own thoughts [7].

Mathematical disposition is the habitual tendency to see mathematics as something plausible, useful and valuable combined with belief in one’s persistence and success [8]. A person who has perseverance in learning mathematics and has a positive mathematical disposition shows a serious effort in solving problems and has the willingness to find way to solve problem [9]. Mathematical disposition has several aspects including self-confidence, flexibility, persistence, interest, tendency to monitor and reflect, respect for the application of mathematics [10]. Details of the mathematical disposition indicators include: (a) having confidence in using mathematics, solving problems, giving reasons, and communicating ideas; (b) having flexibility in investigating mathematical ideas and seeking alternative methods of solving problems; (c) having persistence in doing mathematical tasks; (d) having interest, curiosity and inventiveness in finishing mathematical tasks; (e) tend to monitor, reflect on their own reasoning; (f) applying mathematics to other situations in other mathematical sciences and everyday experiences; (g) appreciating the role of mathematics in the culture and value of mathematics as a tool and as a language [11]. Learning mathematics can improve mathematical thinking skills as a cognitive aspect and an affective aspect of students which is called a mathematical disposition and students learning outcomes [12].

Considering the influence of students’ mathematical disposition on mathematical abilities [13], the importance of problem-solving abilities and mathematical dispositions in mathematics learning, the researchers finally decided to analyze the effect of the mathematical dispositions of vocational high school students in Salatiga with high, moderate, and low categories on their mathematical problem-solving abilities.

2. Method

This study used descriptive qualitative method. Descriptive analysis method is a method used to analyze the available data, which is then processed to obtain a clear picture of the facts and relationships between the phenomena under study [14].

This study involved a sample of the eleventh-grade students majoring in Light Vehicle Engineering at SMK Muhammadiyah Salatiga in the 2019/2020 school year with a total of 25 students selected using purposive sampling technique. This technique was chosen so that researchers can determine individuals as subjects and understand the situation on the focus of their research. There were 3 students selected, each representing a high, moderate and low level of mathematical disposition.

Furthermore, this study utilized instruments in the form of: 1) a mathematical disposition questionnaire using a Likert scale with 4 answers including Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD); and 2) mathematical problem-solving abilities test whose assessment was adjusted to the question guideline and question scoring. The data were obtained from the results of
students' test answers and filling out a mathematical disposition questionnaire. To ensure the validity of the data, data triangulation methods were used by utilizing different data collection techniques to obtain data from the same source [15]. Get conclusions. Moreover, this study also conducted data analysis techniques which include data reduction, data presentation, and drawing conclusions. Data reduction means summarizing, choosing the main points, focusing on the important points, looking for themes and patterns and removing unnecessary points [16]. Thus, the data that has been reduced provides a clearer picture, and makes it easier for researchers to carry out further data collection, and search for it if necessary. The presentation of the data in this study was narrative by processing the information obtained and the conclusions obtained from the results of data reduction.

3. Result and Discussion

In this research, the mathematical disposition questionnaire that had been done by students was used to group students into high, moderate and low mathematical dispositions. Based on the results of a mathematical disposition questionnaire with the eleventh-grade students majoring in Light Vehicle Engineering at SMK Muhammadiyah Salatiga as the respondents, three categories of students' mathematical dispositions were obtained: high (16.7%); moderate (54.2%); and low (29.2%). Three subjects were then taken consisting of representatives of each category of mathematical disposition to identify more deeply about Polya's problem-solving stages they mastered. The results of the analysis are described in Table 1 below:

| No  | Indicators                        | High disposition | Moderate disposition | Low disposition |
|-----|-----------------------------------|------------------|----------------------|----------------|
| 1.  | Understanding the problem         | √                | √                    |                |
| 2.  | Devising the problem-solving plan| √                | √                    | -              |
| 3.  | Carrying out the problem-solving plan | √            | √                    | -              |
| 4.  | Rechecking the answers            | √                | -                    | -              |

The results of the problem-solving abilities test for each subject in the high, moderate, and low disposition categories are shown as follows:

3.1. High Disposition

The results of the work of subject with the high disposition category (S1) for question number 1 can be seen as follows:

![Figure 1. Subject with the high disposition category’s answer for the first question](image)
Based on Figure 1, the subject has been able to write down 4 indicators of Polya's problem solving stages. Subject is able to write down all the stages of problem solving in the form of understanding the problem, devising the problem-solving plan, carrying out the problem-solving plan, and rechecking the answers.

The results of the work of subject with the high disposition category (S1) for question number 2 can be seen as follows:

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**Figure 2.** Subject with the high disposition category’s answer for the second question

Based on Figure 2, the subject has been able to write down 4 indicators of Polya's problem solving stages. The subject is able to write down all the stages of problem solving in the form of understanding the problem, devising the completion plan, carrying out the plan, and rechecking the answers.

The results of the work of the subject with the high disposition category look procedural and structured. Subject wrote down all stages of Polya's problem-solving stages. It indicates that a subject with a high disposition category tends to be confident in solving problems, shown by being able to rewrite the results of rechecking their answers. In devising the problem-solving plan and carrying out the plan, the subject substitutes what is known to the formula that has been written earlier precisely so that the subject can be said to be flexible. The persistence of students in solving problems is an indicator of a student with high mathematical disposition [17].

### 3.2. Moderate Disposition

The results of subject with the moderate disposition category (S2) for question number 1 can be seen as follows:
Based on Figure 3, the subject has written Polya's problem-solving stage in the form of understanding the problem correctly, that is writing what is known and asking about the question. In the stages of planning and carrying out the plan, the subject is able to write correctly. The subject’s work stops only at the stage of carrying out the plan. The subject is not able to carry out the stage of rechecking the answer.

The results of the work of subject with the moderate disposition category (S2) for question number 2 can be seen as follows:

Based on Figure 4, the subject has written Polya’s problem-solving stage in the form of understanding the problem correctly, that is writing what is known and asking about the question. In the stages of
planning and carrying out the plan, the subject is able to write correctly, but he/she does not write the stage of rechecking the answer.

The results of the work of the subject with the moderate disposition category look structured but it is incomplete. Based on Polya's problem-solving stages, the subject is unable to recheck the answer. Rechecking the answers aims to ensure that the answers that have been written are correct. It is to minimize calculation errors so that conclusions can be drawn according to the calculations [18].

3.3. Low Disposition
The results of the work of subject with the low disposition category (S3) for question number 1 can be seen as follows:

Figure 5. Subject with the low disposition category’s answer for the first question

Based on Figure 5, the subject has written Polya's problem-solving stages, including understanding the problem and planning its problem-solving, even though the subject writes it incorrectly at the stage of understanding the problem. Subject wrote “reflection across the line $x = 2$ and $x = 5$”, which should be reflection across the line $x = 2$ followed by $x = 5$. In the problem-solving planning stage, the subject does not continue until it is finished. He only draws incomplete graphics.

The results of the work of subject with the low disposition category (S3) for question number 2 can be seen as follows:

Figure 6. Subject with the low disposition category’s answer for the second question
Based on Figure 6, the subject has written indicator of Polya’s problem-solving stage, that is understanding the problem. Subject only writes what is known and what is asked in the question, but he cannot continue with the next stage.

Subjects with low disposition category writes the answers in a poorly structured manner. This can be seen from the error in writing the answer at the stage of understanding problem number 1. It can be said that subject with a low disposition category has low self-confidence and persistence in solving mathematical problems.

4. Conclusion
Based on the results and discussion, this research concludes that students’ mathematical disposition affects students' mathematical problem-solving ability in working on questions. Each category of mathematical disposition (high, moderate and low) has different abilities in solving mathematical problems. Subjects with a high disposition category are able to write down four indicators of Polya's problem-solving stages which include understanding the problem, devising the problem-solving plan, carrying out the plan, and rechecking the answer. Besides, a subject with the moderate disposition category is able to write 3 indicators of Polya’s problem-solving stages, including understanding the problems, devising the problem-solving plan, and carrying out the plan. In addition, subjects with a low disposition category can only understand the problem in the question. In one of the question numbers, the subject writes what is known incorrectly.

It is important to know the level of students’ mathematical disposition since it greatly influences the success of learning mathematics and can also foster student characteristics [19]. Students' dispositions grow along with mathematics learning. It serves not only to solve math problems but also to solve problems in everyday life [20]. Therefore, it is important for a teacher to know the level of mathematical disposition of the students in order to get maximum results in learning mathematics. Teachers should foster students’ mathematical dispositions in every mathematics learning by making maximum efforts in developing mathematical disposition abilities to students in the form of understanding the importance of mathematics. It can be conducted by the selection and application of appropriate learning methods or models in each lesson in order to build problem-solving abilities and mathematical dispositions.

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