Analysis of difficulties in mathematics problem solving based on revised Bloom’s Taxonomy viewed from high self-efficacy

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Abstract. The ability of solving problem is a part of the mathematic curriculum that is very important. Problem solving prefers the process and strategy that is done by students in solving a problem rather than the result. This learning concept in accordance with the stages on the revised bloom's taxonomy. The revised Bloom's Taxonomy has two dimensions, namely the dimension of cognitive process and the dimension of knowledge. Dimension of knowledge has four categories, but this study only restricted on two knowledge, conceptual knowledge and procedural knowledge. Dimensions of cognitive processes are categorized into six kinds, namely remembering, understanding, applying, analyzing, evaluating, and creating. Implementation of learning more emphasis on the role of students. Students must have their own belief in completing tasks called self-efficacy. This research is a qualitative research. This research aims to know the site of the students’ difficulty based on revised Bloom's Taxonomy viewed from high self-efficacy. The results of the study stated the students with high self efficacy have difficulties site. They are evaluating conceptual knowledge, evaluating procedural knowledge, creating conceptual knowledge, and creating procedural knowledge. It could be the consideration of teachers in the teaching, so as to reduce the difficulties of learning in students.

1. Introduction
Mathematics has a very important role in developing the learners’ ability to think and to be logical. Besides that, math is a tool and servant of sciences, not only for itself but also for the other sciences, and it’s good for the importance of theoretical and practical as an application of mathematics. The purpose of mathematics education is actualizing the student learning at the highest level [7]. But most of students get difficulty. When studying mathematics students have varying views; “students may not have the same conceptions of understanding in mathematics learning when they are studying primary, secondary, or tertiary mathematics” [8].

The National Council for Excellence in Critical Thinking defines critical thinking as the “intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action. The most famous conceptualization of critical thinking comes from Bloom’s Taxonomy [5]. It has been revised for the revised Bloom's taxonomy. The revised bloom's taxonomy has two dimensions, namely the dimension of knowledge and the dimension of cognitive processes. Dimension of cognitive process contains six categories. Those are remembering, understanding, applying, analyzing, evaluating and creating.
Dimensions of knowledge contains four categories. They are factual, conceptual, procedural, and metacognitive [1].

The Common Core State Standards and Partnership for 21st Century Skills emphasize that education should focus on both core academic subject mastery and 21st century skills development [10]. These skills help students to be ready for college and career life. There are various strategies by which to achieve 21st century skills; problem solving, critical thinking, collaborative learning, integration environment, and digital tools in teaching [2][12]. One of the strategies used in 21st century skills is problem solving.

The ability of solving problem is a part of the mathematic curriculum that is very important, because in the process of learning as well as the solution, the students might be possible to get experience using knowledge and skills that already owned to apply in solving problem which is not in routine [8]. Problem solving prefers the process and strategy that is done by students in solving a problem rather than the result [9]. Problem solving that gives priority to the process related to the methods in problem solving (procedural knowledge). Problem solving that gives priority to the strategy related to the basic concepts in completing it (conceptual knowledge).

The implementation of learning mathematics is also inseparable from the role of the students to understand, finish, and solve mathematic problems. Students must have confidence of their ability in completing at ask given to them. The belief in their own ability in completing a certain task is known as Self-efficacy. Self-efficacy refers to personal beliefs about one’s capabilities to learn or perform action at designated levels [3][6]. Self-efficacy is also meant as “Belief refer to the specific expectations that we hold about our abilities to accomplish specific task” [3]. Self-efficacy has a positive impact on person's life especially in learning [14]. The opinions related to self-efficacy indicate that self-efficacy has anenough important role to achieve one's goal. This is due to the student's beliefs about the subjects being studied that guessed to have an effect on the students' achievement towards learning [9]. Self-efficacy produces the difference on how someone thinks, acts, and feels [4][13]. Students with high self-efficacy also have difficulty in finishing the problem solving task. It can be seen in the results of research that has ever been done that students with an average high self-efficacy have difficulty in solving mathematic problem in story task with a percentage more than 50% [9].

One of the materials taught in fulfilling the aspect of algebra is linear equation system with two variables (SPLDV). The material presented in class VIII. Choosing is linear equation system with two variables in this study is caused by a variety of problem in the form of problem solving so can help the researcher in analyzing the students' ability of mathematics problem solving. This material can be made in various types of non-routine task based on the difficulty level on revised Bloom's Taxonomy so can be known the site of difficulty in finishing the problem solving task in terms of self-efficacy.

2. Research Methods
This research is a qualitative research. This research is a qualitative research. This research aims to know the site of the students' difficulty based on revised Bloom’s Taxonomy viewed from high self-efficacy. Categories self efficacy can be seen in table 1.

| Table 1. The Result of Self-efficacy category |
|---------------------------------------------|
| High self-efficacy                          | $X > 76.62$ |
| Moderate self-efficacy                      | $62.57 < X < 76.62$ |
| Low self-efficacy                           | $X < 62.57$ |

The question form Self efficacy have 22 grain statement. The subject of the research taken by using purposive sampling technique. The subjects were students with high self efficacy category. They are subject A and subject B. Subjects were given a matter of mathematics problem solving. The answers are analyzed based on revised Bloom’s Taxonomy. Sites of difficulty based on the revised Bloom's Taxonomy are; remember the concept, remember the procedure, understand the concept, understand
the procedure, apply the concept, apply the procedure, analyze the concept, analyze the procedure, evaluate the concept, evaluate the procedure, create the concept, and create the procedure. They can be seen in table 2. To check the validation of analysis results, researcher uses the triangulation methods. That is by conducting interviews of each subject after answering the problem solving sheet.

| Cognitive Process Dimension (DPK) | Knowledge Dimensions (DP) |
|-----------------------------------|---------------------------|
| Remember                          | Remember Conceptual       |
| Understanding                     | Understanding Conceptual  |
| Applying                          | Applying Conceptual       |
| Analyzing                         | Analyzing Conceptual      |
| Evaluating                        | Evaluating Conceptual     |
| Creating                          | Creating Conceptual       |

3. Result and Discussion
The instrument used to determine the selection of the subject based on the student self-efficacy is the questionnaire of self-efficacy (SE). The results of the questionnaire analysis is used to classify the subject SE with the high, moderate, and low category. This research takes 2 subjects with high SE category. The result of the analysis based on the revised Bloom's Taxonomy points out that the subject with a high SE category has the difficulty site in evaluating conceptual knowledge, evaluating procedural knowledge, creating conceptual knowledge, and creating procedural knowledge. For more details, the result of the analysis can be seen below:

3.1. Analysis of Problem Solving

3.1.1. Question No. 1 for Subject A and Subject B who have a high SE,

**Figure 1. Question 1**

Given the system of equations:
\[
\begin{align*}
5^2 p - 9^2 q &= 2.6^2 - 31 \\
3^2 p + 10^2 q &= 2.10^2 + 118
\end{align*}
\]
There are values p and q satisfying the equation system. Is this equations system a linear equation system with two variables? Justify your answer.

**Figure 1.1** The answers of subject A with high SE on question No. 1

Yes, because p and q satisfy the system of linear equations with two variables

In Figure 1.1 it seems that Subject A can write what is meant; remembering the concept and remembering the procedural. The subject can mention that SPLDV has 2 variables and has a completion of p and q that fulfill both equations. So it can be concluded that the students do not have difficulty in remembering conceptually and procedurally.

**Figure 1.2** The answer of subject B with high SE on question No. 1

Yes, because there are two variables in linear system are p and q
In Figure 1.2 it seems that Subject B only mentions that the equation has two variables p and q. But the mean of answer from subject B was correct, yet Subject B did not answer that p and q is the completion of the second equation.

3.1.2. Question No. 2 for Subject A and Subject B who have a high SE,

| Given two triangles are \( \triangle ABC \) and \( \triangle PQR \). where \( \angle A = 2y \), \( \angle B = 3x + 4y \), \( \angle C = x + 2y \), \( \angle P = 3x - y \), \( \angle Q = 2x + 3y \), and \( \angle R = x + y \). |
|---|
| a. Based on the information existed on \( \triangle ABC \) and \( \triangle PQR \), please make the similarity related to the information above? |
| b. Determine x and y the values of satisfying the obtained equations? |

**Figure 2. Question 2**

| a. \( \angle A + \angle B + \angle C = 180^0 \) |
|---|
| \( 3x + 2x + 3y - 20^0 + 2y - 4x - 20^0 = 180^0 \) |
| \( x + 5y = 180^0 \) |
| \( \angle P + \angle Q + \angle R = 180^0 \) |
| \( 4x - 20^0 + 5x - 2y + 3x + y = 180^0 \) |
| \( 12x + 2y = 180^0 \) |

| b. \( x + 5y = 180^0 \times 12 \) |
|---|
| \( 12x + 60y = 180^0 \) |
| \( 12x + 2y = 180^0 \times 1 \) |
| \( 58y = 0^0 \) |
| \( y = 0^0 \) |
| \( x + 5y = 180^0 \times 1 \) |
| \( x = 180^0 \) |

**Figure 2.1 The answer of subject A with high SE with on question No. 2**

In Figure 2.1 it seems that Subject A understands the information given by the question 2a. So subject A can make the equation of task information. This means subjects do not have difficulty in understanding the problem conceptually. It's just in the calculation of algebra subject A get miscalculations. On a equation in \( \triangle PQR \) is meant \( 4x - 20^0 + 5x - 2y + 3x + y = 180^0 \), the correct \( 12x - y = 200^0 \), but the subject A writing \( 12x + 2y = 180^0 \). This means that subject A is less careful in working on it. So, it can be concluded that subject A does not get difficulty in working on question No. 2a, it's just less careful in doing the calculation of algebra.

In Figure 2.1 it seems that subject A can understand that equation of 2a can be used to find the value of x and y by using the method of elimination. So that the subject does not have difficulty in understanding procedurally. But it's just because the initial equation gets wrong in calculating so that the value of x and y is also getting wrong.
In Figure 2.2 subject B can write the equation of 2a correctly so subject B do not get any difficulties in applying it conceptually. Subject B can also apply both equations to look for the values of x and y using elimination method and substitution methods related to the command no. 2b. So subject B does not have any difficulty in applying procedurally.

3.1.3. Question No. 3 for Subject A and Subject B who have a high SE.

Figure 3. Question 3

In Figure 3.1 it seems that subject A can solve the problem. Subject A can analyze question No. 3 so subject A can find the known elements. So subject A has no difficulty in analyzing conceptually. Subject A can link from what is known to find the third angle by changing the third angle with a symbol. So subject A does not have difficulty in procedural analysis. But when doing algebra calculation Subject A gets wrong that should produce subject A writing down. $20^0 + 3\angle C = 180^0$ the correct $4\angle C = 160^0$, but the subject A writing $5\angle C = 160^0$. This means that the subject A are less thorough in working on it.
In Figure 3.2 it seems that Subject B can analyze the question by knowing the known elements by changing the first, second, third angle with $\angle I, \angle II$, and $\angle III$. It can be seen when the subject B writes $\angle I + \angle II + \angle III = 180^0$ be $20^0 + 3\angle III + \angle III = 180^0$. This means that Subject B knows $\angle I = 20^0$ and $\angle II = 3\angle III$. So subject B does not experience any difficulties in analyzing conceptually. Then it can be seen that subject B can use what is known to find the third angle using substitution method. Subject B can do the question by analyzing on what elements that can be used to find the 3 angles. This means that Subject B does not have difficulty in analyzing procedurally.

3.1.4. Question No. 4 for subject A and subject B who have a high SE,

Given the sum of two positive integers are 55 and the different of two positive integers are 25. Find the two positive integers? Given the reason why do you use that method?

**Figure 4.** Question 4

Because $30^0 + 25^0 = 55^0$

$55^0 - 25^0 = 30^0$

**Figure 4.1** The answer of subject A with a high SE on question No. 4

In Figure 4.1 subject A does not write the requested answer. Subject A just writes $30^0 + 25^0 = 55^0$ and $55^0 - 25^0 = 30^0$. Subject A shows a degree of the settlement suddenly. It's means the answer of subject A is no direction and unwarranted. From the answer written by subject A, subject A gets difficulty on question No. 4. So it can be said that subject A faces difficulty in evaluating the question conceptually and evaluating question procedurally.

**Figure 4.2** The answer of subject B with high SE on question No. 4

In Figure 4.2 Subject B can write the mathematic model from the task "the sum of 2 integers of positive is 55" that is written by separating the 2 integers of positive with A and B. In the second statement, both students have difficulty in writing down the mathematic models. In the statement "the difference of 2 integers is 25". Subject B writes it by changing the 2 integers of cahah with a
symbol which is different with the first symbol that’s C and Dbe $C + D = 25$ the correct $A - B = 25$. Then Subject B only deducts without seeing that there are no variables that can be eliminated in the equation. Subject B writes "the reasons using the method is because easier to understand." Obviously, that’s not a logical reason. It’s means that subject B gets difficulty in determining the mathematic models and difficulty in deciding what method will be used. Seen from the answer that’s not directional, subject B is not able to give the right reason in the use of method which written. So it can be concluded that subject B finds difficulty in evaluating conceptually and procedurally.

3.1.5. Question No. 5 for subject A and subject B who have a high SE,

After a representative of the group determines the bus Agency to rent a bus, now they weigh a package price for the cost of lodging and entrance ticket to the museum. The second package is shown as below. For example, there is a quote from the tour study tour agents offering the package for other costs of hotels and tourist attractions.

For the package A, 3 nights lodging accommodations and attractions 2 tickets are 415 000 USD,-per person.

For the package B, 4 nights lodging accommodations and attractions 4 tickets are 620 000 USD,-per person. Create an problem that can be solved by using systems of linear equations two variables and solve the problems that you have created.

**Figure 5. Question 5**

\[
\begin{align*}
\sqrt{4} + \sqrt{8} &= 80 000 \\
\sqrt{3} + \sqrt{10} &= 70 000 \\
10 000 &\quad -
\end{align*}
\]

**Figure 5.1** The answer of subject B with high SE on question No. 5

In Figure 5.1 subject A is asked to identify the questions related to SPLDV in accordance with the problems given. Written on the answer sheets of subject A ($\sqrt{4} + \sqrt{8} = 80000$), subject A can not write any variables that can be written to be linear equations of two variables. Subject A writes the answers that is not directed to the answer sheet No. 5. The subject A has difficulty on question No. 5 in conceptually even procedurally. So it can be procedural knowledge.

**Figure 5.2** The answer of subject B with high SE on question No. 5

In Figure 5.2 Subject B tries to write what is known without aiming to linear equations of two variables. Subject B only writes 4 boards = ... and 8 pencils= ... That should be made into
equation 4 boards + 8 pencils = 80 000. Subject B is allegedly still having problem in making SPLDV problem conceptually. Subject B is not using the method of SPLDV at all and do not solve the question no 5. It can be concluded that subject B is also still having difficulty in creating procedurally. So subject B gets difficulty in creating the conceptual knowledge and creating procedural knowledge.

3.2. Analysis of the Interview

3.2.1. Partial results of the Interviews with subject A:

Researcher : Do you have any difficulties on the questions given?
Subject A  : Yes, there is a question that i could not do.
Researcher : What number?
Subject A  : Question number 5.
Researcher : Do you have difficulty in making a matterrelated to question No.5?
Subject A  : Yes. I can't make a question related to question no. 5. I was confused the way how to make it.
Researcher : For the question number 4, can you do it?
Subject A  : I have answered it but i am still hesitant.
Researcher : Have you made the mathematic model for question number 4correctly?
Subject A  : I am still confused when i should write the reason using the samemethod.
Researcher : For question number 2, is your answer correct?
Subject A  : No, i was wrong in calculating. It should be negative y.
Researcher : Do you know the mistake of question number 3?
Subject A  : Yes, i should write it.

3.2.2. Partial results of the Interviews with subject B:

Researcher : From question number 1 to 5, any difficult questions?
Subject B  : Question number 4 and 5
Researcher : Question number 4, in which part do you get difficulty?
Subject B  : I was confused to find cacah integer.
Researcher : In the first statement "the sum of positive integer is 55" it can be amathematic model. Why isn't the difference?
Subject B  : Yes, it should use minus.
Researcher : Which is the easiest method to use from the mathematic model?
Subject B  : I was confused how to determine the easiest method.
Researcher : For question number 5, which part do you get difficult?
Subject B  : I could not make a question related to SPLDV.
Researcher : For question number 1,2,3, do you have difficulty?
Subject B  : I can do the question number 1,2,3 as well.
Researcher : For question number 1. Can you mention the other reason?
Subject B  : P and q must satisfy both equations.
Based on the results of the analysis and interviews, it can be concluded that based on the revised Bloom's Taxonomy, subjects with high SE generally still got difficulties in the process of solving problems. In general, subjects with high SE had difficulty in evaluating conceptually, evaluating procedurally, creating conceptually, and creating procedurally.

Based on the research that has been conducted for an average high self-efficacy, the difficulties experienced by junior high school students in solving problem of mathematics is the story questions of understanding the concept, applying the concept, applying the procedure, analyzing the procedure, evaluating the concept, and evaluating the procedure 98.8% [11].

4. Conclusion

Based on the purpose of the research and data analysis that has been conducted by researchers about the site of the students' difficulty in solving material problem of SPLDV based on the revised Bloom's Taxonomy, then it can be concluded that students with high SE are generally able to remember conceptually, remember procedurally, understand conceptually, understand procedurally, apply conceptually, apply procedurally, analyze conceptually, and analyze procedurally in problem-solving questions. But in general, students with high SE are having difficulties at the level of evaluating and creating the problem-solving questions both conceptually and procedurally. Factors that may cause difficulty in solving the problem besides cognitive factors and students' knowledge is that the students are less thorough in working on the question and they are in a hurry.

This can be a concern for educators, that students who have high SE does not mean they have no difficulty level in the process of finishing the problem-solving question. Thus, educators can consider SE category owned by students and expected to be a consideration of teachers in doing the learning process in the classroom, so as to reduce the difficulties of learning in students.

Acknowledgment

The authors would like to thank the referees for their suggestions and thank to Sebelas Maret University, Surakarta, Indonesia for funding this research in the academic year of 2017.

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