Analysis of problem solving skill in learning biology at senior high school of Surakarta

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Abstract. Problem solving is a critical component of comprehensive learning in 21st century. Problem solving is defined as a process used to obtain the best answer from a problem. Someone who can solve the problem is called a problem solver. Problem solver obtains many benefits in the future and has a chance to be an innovator, such as be an innovative entrepreneur, modify behavior, improve creativity, and cognitive skills. The goal of this research is to analyze problem solving skills of students in Senior High School Surakarta in learning Biology. Participants of this research were students of grade 12 SMA (Senior High School) N Surakarta. Data is collected by using multiple choice questions base on analysis problem solving skills on Mourtus. The result of this research showed that the percentage of defining problem was 52.38%, exploring the problem was 53.28%, implementing the solution was 50.71% for 50.08% is moderate, while the percentage of designing the solution was 34.42%, and evaluating was low for 39.24%. Based on the result showed that the problem solving skills of students in SMAN Surakarta was Low.

1. Introduction

The challenge of improvement in science and technology requires students to possess the skills in the 21st century that will be used to compete against the era of globalization and accelerate the rapidly evolving information flow. High-level thinking skills are a very important skill in the 21st century. High-level thinking skill is defined as the highest level of thinking skill that requires students to include analysis, evaluation and creating synthetics [1]. High-level thinking skills are grouped into 4 domains consisting of the digital age, inventive thinking, communication and productive [2]. The 21st century is regarded as a century of transformation in various fields, especially education that requires various skills, one of which is problem-solving skills [3].

Problem solving skill is actually needed in the learning process of science, since science learning cannot be separated from the combination of thinking skills and creativity skill to create a new product [4]. Problem solving skill is a kind of expert thinking that has a strong desire to solve problems in life [5]. Each student has different problem solving skills and it is influenced by several factors. According to Mourtos, Okamoto and Rhee [4], there are six aspects that can be used to measure the extent to which the student problem solving skills, namely 1) define the problem; defining problem encountered, describing problems encountered, determining the information that must be known to define problem, and justify the basis of the criteria to determine the final product, 2) explore the problem, determining the problem-related object, examining the problem related to the assumptions and stating the hypothesis related to the problem, 3) planning the solution in which the student develops a plan to solve the problems, mapping out sub-material related to the problem, select the theory of principles and approaches appropriate to the problem, and determining information to find the solution, 4) implement the plan, at this stage students apply the plan that has been set, 5) check the
solution; evaluating the solution used to solve the problem; and step 6) evaluate; in this step, the solution is checked, assumptions related to the solution is made, estimating the results obtained when implementing solutions and communicate solutions that have been made.

Students of class XII MIPA in SMA Negeri Surakarta have different problem solving skills in the process of Biology teaching and learning process. This is influenced by internal and external factors. Problem-solving skills can be measured by using written instruments, one of them is a multiple-choice test. The multiple choice written test is a written instrument and consists of 2 basic and alternatives problems. That kind of test contains problems with questions of positive or negative preference and alternative choices that indicate true or false [6]. Multiple choice tests to measure problem solving skills is based on some advantages of the instrument. Those advantages are: 1) it can be received in various fields of science showing different thinking level and has high validity, 2) feedback can be obtained quickly, 3) automatic scoring, 4) efficient, 5) can analyze problems from high to low difficulty level, and 6) the score can be used repeatedly [7]. The other advantage of the multiple choice test is that this kind of test does not consider the gender differences that will affect the students' answers [9].

Based on the mentioned reason, multiple choice test was chosen to determine the problem solving skill of XII MIPA students of SMA Negeri Surakarta on Biology teaching and learning process. There are 20 items in the multiple-choice test covering 6 aspects of problem-solving skills. Based on the test, the researcher can calculate the percentage and analyze the problem-solving skills of students class XII MIPA in SMA Negeri Surakarta

2. Research method

This is a quantitative research. Quantitative methods are obtained with result of the students’ written test score. The results of the written test were then analyzed to determine the problem-solving process in each aspect. The subject of this study was the students of class XII MIPA in SMA Surakarta in the 1st semester. The sample used in this study were 198 students divided into 6 classes and each class consisted of 33 students consist of female and male. Data collection technique, the data used in this research was collected by using instrument in the form of multiple choice written test. The multiple choice test consisted of 20 questions covering 6 aspects, including 3 items on aspects of defining problems, 4 items on aspects of exploring problems, 4 items on aspects of planning solutions, 3 items on aspects of using solutions, 3 items on aspects of checking solutions and 3 items for the evaluation aspect. The data was analyzed by using quantitative methods and qualitative descriptive analysis. Score for the correct answer was 1 and score for incorrect answer was 0. The result of all score was recorded based on each aspect. Furthermore, the results were qualified based on the percentage. The calculation of the results of problem solving skills was calculated by using Microsoft excel by using Equation 1.

\[ \% = \frac{t}{t_c} \times 100\% \]  

The result of the next percentage calculation process was then made into 5 categories of decision as follows.

| Table 1. Category of decision analysis. |
|----------------------------------------|
| **Level**    | **Category**       |
| 81-100       | Very good         |
| 61-80        | Good              |
| 41-60        | Moderate          |
| 21-40        | Low               |
| 0-20         | Very low          |

(Source [10])
3. Result and discussion

Problem solving skills are an effort that requires strategies to create a new product used to solve the problem. Efforts to solve problems require two skills: cognitive and thinking skill. Thinking skill is used to identify problems and develop strategies presented in a design of activities used to solve problems. Meanwhile, skill is used to implement a strategy that has been designed to get an answer to the problems faced [4]. The statement is in line with Van Gundy as stated in Carson [11] states that in the process of problem solving, thinking skill and hard skill are needed. Hard skill is used to conduct a series of activities and previous experiences to solve problems that have never been faced or found before. The problem solving skill possessed by the students can be detected through several aspects such as defining the problem, exploring the information, planning the solution, using the solution, checking the solution, and evaluating are 6 aspects that can measure students’ problem solving skill [4].

Based on the results on problem-solving skills in the teaching-learning process of Biology in SMA Negeri Surakarta by using written test instrument in the form of multiple choice questions including 6 aspects of problem-solving skills, it was then obtained the following results:

| Table 2. Result of problem solving skill analysis. |
|-----------------------------------------------|
| Aspects                        | Percentage | Qualification |
|-------------------------------|------------|---------------|
| Defining problem             | 52.38%     | Moderate      |
| Exploring problem            | 53.28%     | Moderate      |
| Planning solution            | 34.42%     | Low           |
| Using solution               | 50.08%     | Moderate      |
| Checking solution            | 34.42%     | Low           |
| Evaluating solution          | 39.42%     | Low           |

Based on table 2, it can be concluded that students’ problem solving skills are as follows:

a. The aspect of defining problem, in this aspect the percentage is 52.38%. It means that the student is sufficiently able to identify the problem in the form of problem sketch and interpret the final result that will be obtained from the problem.

b. The aspect of exploring problem, in this category, the students’ skill of solver is in moderate level, namely 53.28%. At this stage, students are able to search for studies or literature related to the problem, determine the object and make an assumption or hypothesis.

c. The aspects of planning solution, in this aspect the percentage of problem solving skills is in the low level, namely 34.42%. It implies that the students have not been able to apply what has been studied and assumptions/hypotheses, and also in choosing the correct theory and making the framework or the design of the activities used to solve the problem.

d. Aspects of using the solution, the percentage of students’ problem solving skill in this aspect is in the moderate level, namely 50.08%. At this stage, students have the skills to use laboratory equipment used to solve the problem.

e. Aspects of checking the solution, the percentage of students’ problem solving skill in this aspect is in the low level with 34.42%. It indicates that the students’ ability to determine the solution has been established. This stage requires high-order thinking skills to check whether the theory and design prepared and applied is in accordance with the problems or not. At this stage we can consider that the students' thinking skill to analyze and synthesize a theory is still low.

f. Aspects of evaluating, the percentage of students’ problem solving skills in this aspect is in the low category with 39.42%. This stage is a reflection of what we have done and judging from the assumptions/hypotheses that have been determined and whether the strategy is acceptable. Students’ problem solving skills at this stage are still low. It indicates that students have not been able to evaluate and reflect on what has been done.
Based on the results above, we can determine that there is a link between cognitive thinking skills and hard skills, and the output of the two things is in the form of a product which is the answer of the problems found. The result of problem solving skill analysis of students of class XII MIPA SMA Negeri Surakarta is in the moderate and low category. It implies that there must be a big change in science learning process. Such changes can be made through the application of learning models that serve students to perform high-order thinking skills so that they can solve problems. The link between problem-solving skill and science learning lies in the activities during teaching-learning process. If the students’ problem solving skills still in the categories of moderate and low, it indicates that students are not accustomed to use their talents and experience to solve problems in the learning process at school. This weak ability to analyze problems is influenced by some factors, namely 1) not understanding the questions, 2) the low ability to identify problems, 3) low ability to analyze, 4) low ability in mastering concept [12]. Based on result similar to result of Ulya [13], the result showed that problem solving skill student at Kudus is low. This is can be seen from aspects checking solution. On this aspect showed that student has not able to check the result of solving and be arrange the completion with different step. Form the result showed that student has not able to use strategy, checking solution and evaluating. Its means that cognitive skill student to analysis is low. According to Selçuk, Çal and Erol [14] that problem solving skills are simple formula to formalize a new answer to solve the problem. So if the student can’t be more cognitive skills so him/his will be difficulty to solve the problem and make a new product.

In fact, problem solving skills are needed in the process of science learning remembering that science learning is not limited to concepts and facts, but also the process of learning science has procedures and metacognitive. According to Afandi and Sajidan [1], science learning is a reflection of thinking skills that use logical principles accompanied by empirical evidence combined with scientific methods to acquire new knowledge of nature about social life. This is similar to National Science Teacher Association [15] which states that science learning is a learning process that emphasizes the experience of students combined with students' thinking skills to solve problems.

Based on that opinion, we can conclude that problem solving skills are needed in learning, community life and future. This is in line with the statement from Dyer and Gregersen [16] stating that students’ problem solving skills have great advantages including being an innovative person, become a ready-to-compete and ready-to-change person, changing behavior, enhancing creativity and improving skills in terms of thinking. Students with passion in problem-solving will be able to be ready for challenges.

4. Conclusion

In conclusion, problem solving skills of students in class XII MIPA in SMA Negeri Surakarta is not yet optimized. It is proven by reviewing 6 aspects of problem solving skills, namely: 1) percentage of defining problem aspects for 52.38%, 2) aspects of exploring problem for 53.28%, 3) aspects of planning solutions for 34.42%, 4) aspects of using solution for 50.08%, 5) aspects of checking solutions for 34.42% and 6) aspects of evaluating for 39.42%. Based on the analysis of the 6 aspects of the problem skills, it can be concluded that the problem solving skills in the class XII MIPA in SMA Negeri Surakarta on Biology learning is 47.74% and it is moderate category.

Suggestions, improvement of problem-solving skills can be enhanced by the use of a learning model that trains students’ high-level thinking skills so that students are reflected through learning activities.

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