Mathematics problem solving based on Schoenfeld in senior high school students

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Abstract. Mathematics has a goal to improve the ability in critical thinking, creative, analysis, and problem solving. Problem solving is one of the abilities that can improve mathematical knowledge. Mathematics problem solving based on Schoenfeld consists of reading, analysis, exploration, planning, implementation, and verification. Mathematics problem-solving focuses on students' ability to analyze, solve problems, and justify the answer. The aims of the study is to describe student's mathematics problem-solving skills based on Schoenfeld. This research used the qualitative descriptive method. Subject in this study were three students of class XI in Senior High School which is this school is one of the schools favorite in Surakarta which selected using random sampling. The result of this study indicates that two students have mathematics problem solving skills better than the other. Based on the research, it can be concluded that students can solve the problem well but students have not been able to prove the answer obtained by looking for other methods of problem solving. Most students only use problem-solving strategies that are only taught in their school. Students do not try to explore other problem-solving strategies.

1. Introduction

Mathematics is one of the lessons that are a scourge for most students. Most students experience difficulties in mathematics. According to the latest national test results, most student lack mathematics skill [1]. However, mathematics plays a significant role in development of human thinking abilities. Mathematics has a vital role in various disciplines and technological developments in the future. Mathematics becomes one of the subjects taught from elementary to high school. Of all school subjects, mathematics introduces and develops the problem-solving concept as fundamental component of school learning with a sound formative effect on students [2]. Mathematics curriculum aims to provide student environments in which students can make observation, discover, solve problems, share, and discuss their solutions with friends [3]. For mathematics teacher, a problem is defined as an attractive question of whose steps or ways of solution students do not know but have necessary preliminary information [4]. Based on mathematical point of view, a problem means an issue which is to be solved or shown or the way how it should be solved or shown is not clear at a glance or with available information [5]. In mathematics, way of success is related with good problem solving [6].
Problem-solving is a process starting from the minute students is faced with the problem until the end when problem is solved [7]. The importance of problem-solving is particularly emphasized in the field of mathematics teaching with not only newly implemented second education program but also conducted scientific researches [8]. Besides, problem-solving has an essential role in developing intellectual, ability, and mathematics teaching point of view [9-13]. However, analyze the previous lives of individuals as the most critical variable in problem-solving process and individuals perception regarding the experienced situation as the most crucial factor in solving a problem [14]. Problem-solving is one of significant aspect in mathematics curriculum which required students to apply and to integrate many mathematical concepts and skills as well as making the decision [15]. If mathematics is problem solving, then problem-solving can be defined as eliminating the problem situation by using critical reasoning processes and required knowledge [16]. Mathematics problem solving is an essential aspect of mathematics [17]. The implementation of learning mathematics is also inseparable from the role of the students to understand, finish, and solved mathematics problems [18].

To get the optimal result in problem-solving, there are several problems solving steps that should be well-organized used [19]. Many well-known scholars in mathematics had referred to problem-solving as thought, actions, or participation in the particular situation normally unobserved, a strange one without previous observation or knowledge [20-23]. Problem solvers need to apply knowledge and understanding as a basic concept to solve skill related problems including such as reading and calculating through a particular procedure allowing for the precise solution [23]. Key steps used for solving the problem are understanding the problem, planning and looking back for checking what is done is correct or wrong. Problem solving based on Schoenfeld is divided into several stages as follows: (a) reading; (b) analysis; (c) exploration; (d) planning; (e) implementation; and (f) verification [24]. The research aims to describe mathematics problem solving based on Schoenfeld in high school students.

2. Methods
This research used the qualitative descriptive method. The research was conducted in Senior High School which is one of the schools favorite in Surakarta in academic year 2017/2018 (Grade XI). Random sampling did the selected subject. The selected subjects consisted of 3 students. The instrument of this research were tested worksheets. The data was obtained from the student’s test answers.

3. Results and discussion
Mathematics problem-solving test carried out in class XI in senior high school in Surakarta were 30 students. The test to determine mathematics problem-solving skill. Problem-solving based on Schoenfeld consists of several stages, namely reading, analysis, exploration, planning, implementation, and verification. The results obtained from 3 subjects who will be analyzed mathematics problem-solving skill based on Schoenfeld. Some of students answers can be analyzed as follows.
The S1 result above, students had not understood what was known and what asked. From what is known, students did not know what to do first to solve the problem. Students could not formulate, apply, and interpret what was obtained from the problem. Students did not understand the given problem, so the answer is wrong. Based on result of S1, students could not solve the problem. We can see that students know how to look for value of \( r \) (radius). After that students did not know how to do the next step for looking for value of \( a \). The student has known about the terms to determine value of \( D \) on a circle. However, students could not apply it. At all stages of problem-solving based on Schoenfeld, students did not do well. This is because students could not understand what is meant by the problem as such as figure 1.

Figure 1. The answer of Subject 1 (S1).

Figure 2. The answer of Subject 2 (S2).
The results of S2 answers above indicated that students had understood what was known, asked, and from what is known, students know what to do first to solve the problem. So for this stages namely reading, analysis, and exploration. Students could formulate, apply, and interpret what was obtained from the problem. Based on Schoenfeld, this stage is called planning and implementation. Students did not re-check whether what is done is correct. We can see that students did not write the next step to determine value of $a$ if point $A$ is outside the circle. Students were directly determining the value of $a$. Students did not care about the process of how to obtain the value of $a$. For students the result is more important than the process. From all stages of problem-solving based on Schoenfeld, students did not do verification, whereas verification is the most critical stages as such as figure 2.

![Figure 2](image)

Figure 2. The answer of Subject 3 (S3).

Based on figure 3, the results of S3 answers indicated that students had understood what was known, asked, and from what is known, students know what to do first to solve the problem. So for this stages namely reading, analysis, and exploration. Students could formulate, apply, and interpret what was obtained from the problem. Based on Schoenfeld, this stage is called planning and implementation. But, students did not re-check whether the answer is correct or not. The S3 result above, students could not determine the boundaries of $a$, but students could already determine the number line on the problem. So, students could not write the form of number lines into mathematical forms. The answer should be the problem $-6 < a < 1$ and $a < -6$ or $a > 1$, but students write it with $a = -6$ or $a = 1$. Based on the result of S3, showed that students solved the problem throughly and could not perform verification stage.

For some of the student's answer, it can be seen that most students still have difficult in solving the problem. When students had not understood the problem, they have difficulties in understanding the language and the mathematical terms used. Students could not bring meaning to the problems, did not know how to plan, and perform the problem solving strategies [15]. When students had understood the problem, they still could not solve the problem. They faced difficulty in making connection of the problem, so formulas could be inaccurate and planning on how to execute the solving was difficult and incorrect [15]. Most students only attach importance to the results of the problem rather than the process, but the process is hierarchy.

Most students in solving the problem still make mistake in the working procedure. Many of the students were having difficulties in calculation. So, students made errors in their solving-procedure as well as got the wrong answer. The students mostly used strategies that taught by the teacher but they
were not able to use several other strategies. Besides, when we looked at the student's answer, it was seen that students prefer use same problem solving strategies. Students could either not solve the problem or the same strategy was used by the ones who could solve the problem [25]. Using various strategies for solving the problem can contribute to the development of the mental structures of the students.

4. Conclusion
Based on the research, it can be concluded that students can solve the problem well. Problem Solving based on Schoenfeld in senior high school students showed that the stages of problem solving done were reading, analysis, exploration, planning, and implementation. However, students have not been able to prove the answer obtained by looking for other methods of problem solving. Most students only use problem-solving strategies that are only taught in their school. Students do not try to explore other problem-solving strategies.

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