Profile of students' creative and innovative thinking in solving open-ended mathematics problems about the coffee plantation

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Abstract. Creative and innovative thinking skills become an important thing for students to solve a problem. This research aims to describe the students’ ability of creative and innovative thinking for solving open-ended problems about coffee plantations. The type of this research is qualitative descriptive. This research was conducted on the students of class VIII B Junior high school 1 Jember. The instruments used were creative and innovative thinking test in the form of open-ended problems and interview guidelines. The data collection methods used in this research were test methods and interviews. After all students of class VIII B had been given the test, then research subjects were selected using snowball sampling technique to get saturated data. Based on the data analysis, the profile of class VIII B students’ creative and innovative thinking skills with 36 students is: 44% fulfilling 4 indicators, 19% fulfilling 3 indicators, 0% fulfilling 2 indicators, 6% fulfilling 1 indicator, 31% fulfilling 0 indicators. It shows that generally, students have quite good creative and innovative thinking skills. Students can use several ways to solve problems. Students are able to find unique ideas to solve problems. Students expand, select, analyze and evaluate the basic idea of problem solving. Students use the creative idea on the innovation of problem-solving.

1. Introduction
Education is a very basic thing for the future of the nation. Through education, we can increase the quality of human resources so that it can affect positively the nation life. One of the sciences given from elementary school to senior high school is mathematics. Mathematics is often called as an exact science related to the reasoning [1]. Recently, the education world is required to follow the progressive development of science and technology. It makes thinking skills and collaboration effectively become a must in facing competition [2]. The ability that the students must own recently focuses on higher-order thinking skills [3]. Thus, the students get enough knowledge and skills in facing the challenge of the future. The skills needed in the 21st century are: (1) Learning and innovation skills; (2) Information, media, and Technology skills; (3) Life and career skills [4]. There are several indicators of Learning and innovation skills including Creativity and Innovation, Critical Thinking and Problem Solving, Communication, Collaboration. Therefore, creative and innovative thinking skills become one of the absolute aspects considered important for students in the 21st century.

A creative mind is capable of imagine innovative answers to questions, and it is characterized by flexibility and plasticity [5]. Increasing creative and innovative thinking can use a problem giving that can develop reasoning, knowledge, and skill. Mathematics learning that can measure students’ ability one of them is by using open-ended [6]. According to Nohda, the use of open-ended problems can stimulate creativity and encourage students’ creative activities in solving problems [7]. Open-ended
problems have two types, that are: (1) one answer many ways of solutions, (2) many ways of solutions many answers.

Creative and innovative thinking on learning in class especially in mathematics can train students in applying the knowledge they have studied to find the problem solution. The involvement of creative and innovative thinking on students can increase problem-solving skills and can give a positive perspective on their learning process [8]. In other words, creative and innovative thinking will be very useful in mathematics learning emphasizing tenacity and accuracy to find problem solutions. The ability, such as non-standard thinking, makes a conclusion that unexpectedly can be useful for many fields in the future [9]. Creative thinking is related to all of the perspectives, and a strong belief in any particular perspective may result in a tendency [10].

Mathematics problems existing in the coffee plantation is quite diverse. Many mathematics concepts used in the coffee plantation, one of which is linear equation system of two variables and Social Arithmetic. The concept of linear equation system of two variables is usually used when determining many combinations of coffee types that can be bought with the amount of money owned. With the concept of linear equation system of two variables, we can find many instruments needed to produce an effective calculation. Besides, Social Arithmetic is also used to make the design or prediction of coffee plantation making to estimate the number of coffee trees needed to find a maximum advantage. All those things are directly related to the existing mathematics concept. Therefore, this research takes several problems that exist in the coffee plantation.

Jember Regency is one of the areas that have a big contribution to coffee productions. The amount of coffee productions is also supported by the existing University of Jember which makes a theme of coffee as one of seven superior kinds of research [11]. However, it is not in harmony with the education index that is still classified as low in the area of East Java [12]. Looking at the reality of the big coffee plantation area with a low education index, it is interesting to know how student's creative and innovative thinking is about coffee plantation as a basis to increase HR quality of coffee plantation areas, especially in Jember Regency.

2. Research method

The type of this research is qualitative descriptive. In this research, the description is the profile of students’ creative and innovative thinking. The research subjects are students of Class VIII B of junior high school 1 Jember. The data collection methods used are test methods and interviews. The research activities are started by giving a test to the students of class VIII B with the number of 36 students. Based on the test result, students were selected using a snowball sampling technique for the interview until deciding saturated data. Data analysis is done in the test result and interview. The analysis of the interview result is done by data reduction, triangulation, presentation, and concluding.

Creative and innovative thinking can be seen from several indicators according to Partnership For 21st Century Learning that has been developed, as can be seen in Table 1.

| Table 1. Indicators of creative and innovative thinking |
|---------------------------------------------------------|
| **Aspect** | **Indicator** |
| --- | --- |
| Creative thinking | 1. Students use several ways to solve problems. |
| | 2. Students find unique ideas to solve problems. |
| | 3. Students expand, select, analyze and evaluate the basic idea of problem solving. |
| Applying innovation | 4. Students use the creative idea on the innovation of problem-solving |
The problems given are open-ended problems that have a type of many ways one answer and many ways many answers. The problems used in this research can be seen on Figure 1.

![Image](image.png)

**Figure 1.** Test questions of creative and innovative thinking.

3. Research results

Based on the research that has been done, the students of class VIII B of SMP Negeri 1 Jember shows quite good creative and innovative thinking skills. Data obtained can be said as saturated until the fourth subject retrieval. The analysis result from the test and subject interview can fulfill all indicators well.

Students are selected using a snowball sampling technique for the interview. Subject retrieval is done continuously until getting saturated data. The analysis result of the test and interview shows suitability. The result obtained is as follows.

S1 student shows good creative and innovative thinking skills because able to fulfill all indicators. The following is the solution of S1 student for question number 1.

Based on Figure 2, S1 shows that it can solve the problem in 3 ways (Code of A1). Seen that the first way used by S1 uses example and the solution used is substitution that is the same as what the teacher taught. The second way of S1 is dividing the first equation by 2 which produces equation 3, then reducing the first and second equations producing the fourth equation, next the third equation is reduced by the fourth equation. The third way of S1 is by seeing from the pattern that appears from the
figure on the question. This can be seen from the way the student encircles the pattern that appears in the figure made. The second and third ways show that S1 can find unique ideas to solve the problem (Code of B1, B2) This is an innovation in problem-solving. The following is the solution of S1 student for question number 2.

Based on Figure 3, on question number 2a can be seen how S1 analyzes information that exists on the question to determine the relationship between the weight of coffee seed with the amount of coffee seed so that S1 has found the number of coffee seed needed (Code of C1). Besides, S1 answers by different ways from other subjects, because S1 translates 100 coffee seeds that are the same as 15-20 grams as a stretch, so that S1 find maximum and minimum amount of seeds, although on the answer of
looking for the number of minimum seeds S1 seems not to write multiple by 100, the answer has been correct. At the final answer, S1 writes the stretch of coffee seeds needed from the minimum to the maximum.

Figure 3. Answer sheet of S1 to solve the problem of number 2.

On question number 2b, S1 expands basic ideas through the relationship of many branches, bunch, and seeds that exist on one tree. S1 example from many seeds in one bunch, many bunches in one branch and many branches in one tree (Code of C2). Besides, S1 also finds many maximum and minimum trees as the previous answer of 2a.

On question number 2c, S1 can select from the income factor in the expenditure and income so that it can get the correct result (Code of C4, C6). It is clear that S1 tries to find minimum cost first (Code
of C3) so that taking a number of the least trees needed multiplying by the cheapest cost of coffee tree seedling so that found total expenditure. Then, S1 continues by looking for selling price without profit form the minimum expenditure and looking for the profit obtained by determining a bigger selling price from the selling price without profit that has been determined. It continues to find the maximum cost (Code of C5) by choosing the number of maximum trees needed to plant from the price of the most expensive coffee seed so that it found total expenditure. Then, S1 continues by looking for selling price without profit and the profit obtained by determining a bigger selling price without profit that has been determined.

Based on the interview result, S1 can fulfill the indicator using several ways to solve the problem. On problem 1, S1 does not feel difficulty in solving the problem, even S1 also feels that other ways can be used to solve it. Besides, S1 can also solve by the other way the teacher normally taught. Students fulfill the indicator to find unique ideas to solve problems. On problem number 1, S1 divides two because equation one has the same number of coffee powder and coffee seeds that is 2 so that it can be directly divided by 2. From this, S1 finds the idea to solve the problem. Besides, S1 also has experience in solving this type of problem. On the third way, S1 seems to make an illustration with the figure of lots of coffee powder and coffee seeds with the price according to the information that exists on the question. If noticed, S1 encircles the pattern that occurs on coffee powder, also comparing the difference of total prices and then determining total prices on the third equation. S1 fulfills the indicator of expanding, selecting, analyzing and evaluating the basic idea of problem-solving. On question number 2a, S1 can find out the relationship between the information and mathematics concepts that exist and can explain in detail the reason to use the way. S1 finds the maximum and minimum because seeing from the stretch of coffee seed weight. On question number 2b, S1 determines the number of bunches bunch and seeds by calculating from the shown figure on the question. It becomes a basis of S1 to estimate the number of each seed, bunch, and branch correctly and suitable with the reality. On question number 2c, S1 can explain in detail and use the right way in answering. S1 can explain the thing that has not been figured on the answer sheet although it must be asked first about the unclear thing in the answer. S1 fulfill the indicator of using the creative idea on the innovation of problem-solving. On question number 1 of the second way, although S1 uses the concept of linear equation system of two variables commonly, the steps used are different. It shows that S1 can apply creative ideas. On the third way, S1 states that the patter figure will form stairs triggering the emergence of the idea. Therefore, S1 underlines the figure that has been made resembling stairs. It is different from other subjects because only S1 subject who use the way.

Class VIII-B that has 36 students are generally able to fulfill all indicators well. The following is the recapitulation of the analysis results of each indicator.

![Indicators of creative and innovative thinking](image)

**Figure 4.** The recapitulation of class VIII-B analysis results of each indicator.

Class VIII-B with 36 students is 44% able to fulfill all indicators, 19% able to fulfill 3 indicators, 0% able to fulfill 2 indicators, 6% able to fulfill 1 indicator, 31% able to fulfill 0 indicators.
Based on the analysis that has been done, there is a tendency of the answer given by students based on the indicator of creative and innovative thinking shown in Table 2.

| Indicator | Creative and Innovative Thinking Skills |
|-----------|----------------------------------------|
| Use several ways to solve problems | Students can use several different ways according to their knowledge. Besides the common way taught by the teacher, students also use a unique and rarely used way in problem-solving. |
| Find unique ideas to solve problems | Students can find unique ideas that are different from way normally taught by the teacher, students find ideas with the help of an illustrated figure in the questions and experiences they have in solving similar problems. |
| Expand, select, analyze, and evaluate basic ideas from problem-solving | Students can expand, select, evaluate, and analyze the information they have got well, however, some students do not write the whole information as a basis to solve problems, although the students can explain well in the interview. Besides, students are also able to determine necessary information as basic ideas of solution logically and closely to reality. |
| Use the creative idea that is useful for problems where innovation occurs | Students can use innovative ways based on the creative idea they have so that it brings up different ways from the usual ones. Although some students do not write the whole steps in the answer sheet, they can explain well on the interview stage. |

Based on the analysis of test and interview results, the profile description of creative and innovative thinking is as follows. The first indicator is using several ways to solve problems. Students understand well the useful mathematics concepts in solving problems so that they can find several ideas from the right solution. Students sometimes feel difficulty in understanding the meaning of questions about non-standard ways. Besides, because the question model uses open-ended solutions so that students must think harder to be able to understand the question. The second indicator is finding new ideas to solve problems. Students can find new ideas that are different from the previous one. Students can find new ideas from the point of view in solving problems. The point of view found is based on the knowledge and experience the students have. Students in finding those new ideas get the idea though the existing illustration on the question or illustrating again on the answer sheet. Students understand well the idea used in solving problems. It can be known from the students’ explanation about the reason they use the idea in detail. Besides, students can use the idea rarely used by students so that they show that those ideas appear from students’ original though. The third indicator is expanding, selecting, analyzing and evaluating the basic idea of problem-solving. Students can analyze the information that exists on the question to become a basic solution. Students in analyzing the information can expand the basic idea that becomes a guideline to develop the way so that they get the solution. Students can also evaluate basic ideas by using the right way to find the profit starting from selecting factors that become expenditure and income. It shows that the third indicator is fulfilled well by the students. The fourth indicator uses to describe students’ creative and innovative thinking can use creative ideas on the innovation of problem-solving. The analysis result of students obtained shows that the students can apply innovation in solving the problem. It can be seen from the students’ answer that has been able to find the solution that is normally not taught by the teacher and it is a rare way used by the students commonly. Besides, some students find unique or not the usual concept used in the problem. The fulfillment of the fourth indicator which is the indicator from the aspect of applying innovation shows the relevant relationship between the emergence of students’ innovation.
and the use of open-ended problems. As Becker and Shimada’s opinion [13], the use of open-ended can stimulate creativity, original thinking skills, innovation in mathematics.

4. Conclusion and suggestions

4.1 Conclusion
Students of class VIII B of junior high school 1 Jember tend to able to solve problems related to the coffee plantation. Students can fulfill all indicators of creative and innovative thinking. Students can use several ways to solve problems. Students can understand the meaning and mathematics concept needed so that they can use several ways in solving problems. Students find new ideas to solve problems. Students think creatively in finding ideas that can be used and useful for the solution. Besides, students can explain by logic reason about the idea they found so that the idea they got is original from the students’ though. The idea found by the students is the idea that is rarely used by the student commonly so that it needs high creativity to be able to find the idea. Students can also expand ideas they have got from the information in questions, select useful things for the solution, analyze information on the question and evaluate by using the right way in solving problems. The use of open-ended problems makes the student able to think divergently so that they can determine what to get from the question and what to find. Some information is deliberately removed so that the students can think to find them. Students use the creative idea on the innovation of problem-solving. All students fulfill this indicator because the students can use innovative ways in solving problems by using non-standard ways. Students use innovative ways and can explain well about the reason for using the solution, although several answers are not systematic in solving them. Therefore, it can be concluded that students of class VIII B have good creative and innovative thinking skills in solving open-ended problems with coffee plantation.

4.2 Suggestions
Based on the conclusion results, there are some suggestions as follows.
1) Students would tend to give innovation on problem-solving if given a special command on the question to solve problems with non-standard ways.
2) This research can be developed with different points of view from the side of mathematics ability, learning style, cognitive style, and other things by still making the coffee plantation as the theme used.

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