Unleashing Creativity in Year 8 Students: An Open-Ended Approach to Statistics Education

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Abstract. This research aims to assess the level of creative thinking of Class 8 students when exposed to an open-ended statistical approach. Using a quantitative descriptive approach, this research was conducted on grade 8 students at a state junior high school in Banda Aceh, Indonesia, consisting of four classes. The sample for this study comprised 28 Year 8 students, was randomly selected. Creative thinking skills are assessed using the Torrance Tests of Creative Thinking (TTCT) on statistical material. The collected data was analyzed descriptively to determine the level of students' creative thinking and continued with short interviews with students who had low levels of creative thinking abilities. The results showed that of the 28 students, 3 (11%) were very creative, 6 (21%) were creative, 9 (32%) were creative, and 10 (36%) were classified as less creative. One of the reasons why there are still many students who have a low level of creative thinking is because students do not receive enough practice in solving open-ended mathematics problems. Therefore, future research needs to make further efforts to support improving mathematics learning through an open-ended approach with lots of practice and analyzing more deeply each level of students' creative thinking.

Keywords: Creative thinking, Open-ended approach, Statistics

1 Introduction

The 21st century presents its own challenges for humans in facing complex living world problems. Social and economic developments in that century meant that educational institutions had to equip students with new skills and competencies. Many aspects influence problem solving, such as religion, morality, knowledge, skills, health, and society [1]. Individuals acquire these aspects through the subjects presented at school. In relation to problem solving, mathematical creative thinking skills need to be the focus of attention because of the importance of organizing students' thinking and reasoning skills in connecting them with real life situations [2]. In addition, Republic of Indonesia Government Regulation Number 17 of 2010 in the 2013 Curriculum concerning Management and Implementation of Education stipulates that the aim of implementing primary and secondary education is to build a foundation for developing the potential of students to become knowledgeable, capable and capable people. people. critical, creative and innovative human beings [3]. Therefore, to support these demands, educators can adopt teaching approaches designed to foster students' creativity, harness their intellectual potential and encourage the discovery of new knowledge.

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Unfortunately, the creative thinking ability of junior high school students in Indonesia is generally low [4]. This statement is reinforced by Florida et al. in the Global Creativity Index, reporting that creativity in Indonesia is ranked 115 out of 139 countries. Creativity is the ability to produce new ideas in dealing with a problem. Creativity is the ability to generate new ideas when addressing a problem and is indispensable for solving everyday challenges. Teachers are anticipated to design learning methods and approaches that foster students' creativity. However, before this, teachers must ascertain the level of creativity students possess by assigning problems that require singular and multiple solutions [5].

The open-ended approach is an approach that is able to overcome problems in various ways and thereby utilize students' intellectual potential and experience in discovering something new [6]. The open-ended approach starts from the perspective of objective assessment of students' abilities and higher-order thinking in mathematics [7]. Therefore, this approach is very suitable to be applied in mathematics learning in order to determine students' creative thinking skills.

Creative thinking involves fluency, flexibility, originality, and elaboration [4]. Mathematical creative thinking ability can be assessed based on these four indicators. Another method involves using open-ended problems to measure mathematical creative thinking ability [8]. Open-ended problems are characterized by various solutions [9]. Fluency, flexibility, novelty, and detail can be examined through solving open-ended problems. Consequently, open-ended problems are administered to evaluate students' levels of mathematical creative thinking skills [10]. The capacity to think creatively enables students to approach mathematical problems not just with a singular solution in mind but with an openness to various problem-solving methods.

Some experts have developed instruments to measure mathematical creative thinking ability, such as Balka and Torrance [11]. Balka [12] developed the Creative Ability Mathematical Test (CAMT) instrument, and Torrance developed the Torrance Tests of Creative Thinking (TTCT) instrument. Silver [11] explained that to assess the creative thinking of children and adults, the "Torrance Tests of Creative Thinking (TTCT)" is commonly used. The three critical components assessed in creativity using the TTCT are fluency, flexibility, and originality. Fluency refers to the number of ideas generated in response to a prompt. Flexibility is seen in the changes in approach when responding to a prompt. Novelty is the originality of the ideas made in response to the command.

While research on creativity has been conducted previously, there are still limited studies on statistics, with existing research primarily confined to case studies. Consequently, this study endeavors to elucidate students' creativity through an open-ended approach to statistics. The primary objective is to ascertain students' creativity in solving mathematical problems related to statistics by implementing an open-ended approach. In this context, creative thinking entails discovering new ideas through novel approaches and flexible problem-solving, emphasizing fluency, flexibility, and originality in a junior high school in Banda Aceh, Indonesia.

2 Method

This study employed a descriptive research design with a quantitative approach. The research design was a one-shot case study, utilizing creative thinking skill test, comprising three items. The population included all Year 8 classes from a public junior high school in Banda Aceh, Indonesia, encompassing four classes. Simple random sampling was employed as the sampling technique since all Year 8 classes in the public junior high school in Banda Aceh, Indonesia, shared the same level without any class distinctions. The sample for this study comprised 28 Year 8 students.

Data were collected through a structured test on statistical material with three questions arranged based on indicators of creative thinking ability. Of course, this was done after the statistics learning had been facilitated in three meetings. Next, short interviews were conducted with only a few students who fell into the low creative thinking category to support the findings.

Finally, the researchers checked each student's answer sheet, evaluating the achievement of creative thinking criteria, including originality, fluency, and flexibility based on the TTCT test. The results of the examination were then categorized into five levels of creative thinking ability, which calculated the percentage of students at each level of creative thinking by considering the level of very creative, creative, quite creative and less creative abilities.

3 Results and Discussion

This research was carried out in a public junior high school in Banda Aceh, Indonesia, involving 28 Year 8 students. The aim was to delineate the levels of student creativity through an open-ended approach to statistics. Following the administration of the test, the students' responses were analyzed to categorize them into four groups: highly creative, creative, moderately creative, and poorly creative. Based on the obtained scores, the researchers selected four students representing the analysis results of their answer sheets, each chosen from the categories of highly creative, creative, moderately creative, and less creative. The students representing the four levels were NZ, RF, KS, and BL.

Table 1. Achievement of student creative thinking indicators

Student Name	Total score	Category
NZ	16	HC
RF	12	C
KS	8	MC
BL	4	PC

Note. HC: High Creative, C: Creative, MC: Moderately Creative, PC: Poorly Creative

Based on the data in Table 1, the achievement of creative thinking indicators of Year 8 students can be presented in percentage in Table 2.

Table 2. Percentage of students' creative thinking level

Level	Category	Learning Outcomes	
		Student Frequency	***Percentage***
Level 4	Highly Creative	3	11%
Level 3	Creative	6	21%
Level 2	Moderately Creative	9	32%
Level 1	Poorly Creative	10	36%
Total		28	100%

Based on the analyzed test results in Table 2, the assessment of students' creative thinking levels revealed that three students (11%) out of 28 students were categorized as highly creative. This categorization is indicated by these students meeting all three indicators of creative thinking skills in all test items. Additionally, six students (21%) were categorized as creative. In general, these students could satisfy two indicators of creative thinking skills, either flexibility and originality or fluency and originality, in two test items. Students with moderately creative skills comprised nine individuals (32%), generally fulfilling only two indicators, namely flexibility, and fluency, in two test items. Students at the poorly creative level consisted of ten students (36%). Generally, they could only fulfill one indicator: fluency in one test question. The following are two out of three test items used in this study.

(Problem 1) The mode and median of the weight of a group of 8 students are 40 and 45, respectively. Determine the individual body weight of each student! Are there other methods you can use to solve it?

(Problem 2) Create two sets of data with a range of 40. Can you speculate whether the interquartile range of these two data sets is also the same? Please provide an example and check its accuracy.

In general, the students in this study have not been able to achieve all three indicators of creative thinking. The most dominant indicator achieved by students is fluency and the least indicator achieved by students is originality. Students with creative thinking dominated the fluency, flexibility, and originality indicators. In general, their answers are very flexible because they can develop different and correct ways of solving and are also able to provide and express new ideas from the given problem. Meanwhile, students with moderately creative skills can achieve fluency and flexibility indicators.

Students at the poorly creative ability level dominate the fluency indicator only. Subjects at this level think constantly and still rely on memorization. The subject also had great difficulty understanding the problems and took a long time to answer the problem and think of a solution to the problem. The subjects just copied the answer from their book and also did not re-examine the ideas they had written. Based on the data obtained from the analysis of student answers. The overall level of creative

thinking ability of Year 8 students, in solving creative thinking tests is in the less creative category; this research is in line with previous research [13].

In the test items given, students have difficulty solving problem 1 because students are required to solve problems with novelty indicators, namely, showing new ways of solving and producing correct answers. Many students did not solve until they found the final result. Meanwhile, Problems 2 and 3 can be solved by most students.

Based on the outcomes of interviews conducted by researchers, several factors contribute to students encountering difficulties when tackling open-ended problems. These factors include 1) inadequate comprehension of the problem due to a lack of prior training in addressing open-ended problems, 2) prolonged ideation periods, even when students have a conceptual understanding derived from textbooks, 3) a tendency among students to furnish answers by adhering strictly to procedural steps without engaging in a deeper recall of previously taught material, and 4) neglecting to verify their responses. These findings align with the observations in the previous study [14].

In addition to student-related factors, teachers contribute to the challenges by assigning a limited number of tasks and exercises, while the teaching and learning models remain predominantly teacher-centered. Furthermore, the current online learning environment exacerbates the issue, as students may struggle to promptly comprehend the material when relying solely on books and the internet without adequate explanation and guidance from the teacher. Another research [15] identified factors hindering students' creative thinking skills, such as the use of routine problems leading to difficulties in translating problems into mathematical expressions and solving creatively posed questions. Additionally, previous study highlighted another impediment –the tendency of students to memorize formulas and follow predefined steps provided by the teacher, underscoring the continued centrality of the teacher in the learning process [16].

Despite challenges faced by both teachers and students, the utilization of open-ended problems in mathematics should be promoted. These problems, in contrast to those with singular solutions, encourage exploring diverse ideas and approaches, facilitating mathematical communication and the development of high-order thinking skills [17]. Ensuring the effectiveness of open-ended problems lies partly in the careful selection of contexts; choosing familiar contexts aids students in their problem-solving thinking and communication [18].

While implementing open-ended problems may present obstacles, their positive impact on students' mathematical engagement and cognitive skills underscores the importance of persevering through these challenges. By emphasizing familiar contexts, educators can enhance the effectiveness of open-ended problem-solving exercises, promoting a deeper understanding of mathematical concepts. As discovered from short interviews with several students who were at a low level of creative thinking, one of the causes that made students experience difficulty in solving open-end questions was that students did not understand the questions well because they were unfamiliar or lacked understanding. training to work on open questions.

However, this research is not without limitations. It should ideally involve multiple tests to yield more comprehensive results. Unfortunately, due to time constraints, only one test was conducted. Additionally, in the analysis of students' responses, it was observed that some students failed to articulate solutions coherently. For instance, certain students presented repetitive data sets, posing challenges for

researchers in accurately assessing the level of creative thinking based on the rubric provided for the question.

4 Conclusion

It is concluded that, overall, Year 8 students in this study have not met the three indicators of creative thinking. The most prevalent indicator students achieve is fluency, whereas the least attained indicator is originality. Regarding the level of creative thinking ability of Year 8 students from this particular junior high school when solving tests using the open-ended approach on statistics material, the breakdown is as follows: 3 students (11%) are categorized as very creative, 6 students (21%) fall into the creative category, 9 students (32%) are classified as moderately creative, and 10 students (36%) are deemed poorly creative. One of the causes of students' low level of creative thinking is because students do not receive enough practice on open ended questions.

It is recommended that further research be conducted to identify factors influencing the enhancement of each indicator of students' creative thinking skills. This would enable a more in-depth analysis of each indicator. Additionally, since creative thinking is a high-level skill that can be challenging to improve, efforts to enhance creative thinking skills may be more appropriate in schools with advanced clusters before extending to schools with lower clusters, ensuring sustainability in implementation.

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