ANALYSIS OF STUDENTS' CREATIVE THINKING ABILITY IN MATHEMATICS LEARNING: INSTRUMENT SCALE AND EVALUATION RESULTS

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Abstract. This study aims to describe students' creative thinking skills in mathematics. The type of research used in this research is descriptive research. The population in this study was junior high school students in Bengkalis Regency, Riau. At the same time, the sample was students in the Bathin Solapan District and students from the Bandar Laksamana sub-district. The sampling technique in this study was simple random sampling. The data collection technique in this study was a survey using a questionnaire instrument. Before the instrument is used, the instrument in the form of a questionnaire is validated in content and construct. Content validity analysis uses the Aiken formula and CFA First Order, while construct validity uses CFA Second Order. Data analysis in this study used descriptive statistics. The results obtained from the analysis of students' creative thinking abilities in mathematics at the junior high school level show that the indicators of Elaboration, Flexibility, Originality, and Fluency in students' creative thinking abilities obtain a good category percentage of 22.02% and a lousy category of 77.98%. The evaluation results show that the creative thinking skills of junior high school students in Bengkalis Regency still need to be in the better category. Teachers should use discussion techniques with students and interactive learning resources to foster students' ability to think creatively and actively.

Keywords: *Creative Thinking Analysis, Mathematics Ability, Junior High Schools*

1. INTRODUCTION

Mathematics is a means to support learners in achieving the expected competencies [1], [2]. All levels of education offer mathematics because of its significance in measurement and calculation. Thus, mathematics is a fundamental subject that has a significant impact both in everyday life and in advancing science and technology. In addition to covering as much material as possible, learning mathematics at school helps children to think critically, creatively, and logically [3]. By learning mathematics, students are expected to develop the competencies they want to achieve. One of the competencies that students want to achieve is to be able to think creatively. Mathematics is the most important science among other subjects. Mathematics is one of the exact sciences that is the same as other learning sciences

that prioritize creative thinking rather than memorization [4]. Education is the change desired and aspired to by the educational process, both at the level of relationships and the surrounding environment, and teaching as the main function and profession of society. The training focuses on changing people's behavior with ethical training implications. In addition, human productivity and creativity are also emphasized in the training so that they can participate and contribute to community life [5]. From the above understanding, we can know that education is a foundation for doing everything.

The importance of students learning mathematics is to organize the ability to think, reason, solve a problem, communicate, and relate mathematics to the situation in the surrounding environment, and it is hoped that students will be able to use and utilize technology properly. The ability of students to think mathematically creatively is what is discussed in this study as the main objective. Another aspect of students' intelligence is their ability to think independently [6]. This intelligence triggers the formation of the ability to find a solution to a problem. Mathematical thinking ability refers to the ability to generate varied and novel solutions to open-ended mathematical problems [7] Because creative thinking in learning mathematics is an integral part of life skills for students in facing the rapid advancement of science and technology [5].

The teacher's role in developing students' mathematical creative thinking skills is undeniable [8]. A learning process that encourages learners to think in a purposeful and nurturing way is a key foundation for the growth of creativity in mathematics. Teachers have a great responsibility in creating a learning environment that facilitates exploration, experimentation and discovery. By continuously applying innovations in teaching methods and in the construction of challenging math problems, teachers play a key role in building learners' confidence to think beyond conventional boundaries. Through this approach, learners not only rely on memorizing and applying formulas, but also acquire critical thinking skills that enable them to find creative solutions to complex mathematical problems. Thus, the teacher is not just a conveyor of information, but also a facilitator who inspires and motivates learners to explore the world of mathematics with unlimited courage and curiosity.

Humans are born with the capacity for creative thinking, which needs to be strengthened and trained. In the classroom learning environment, teachers are expected to guide students to improve their creative thinking skills. One of these involves regular teaching that gives students the opportunity to express and develop their ideas freely, but always with the teacher acting as a facilitator and providing direction [9]**.** The capacity to solve problems or create thought structures, communicate claims that differ from accepted deductive logic, and create broad concepts to connect key mathematical ideas are all examples of mathematical creative thinking [10]**.**

Thinking is the accurate and complete application of concepts, starting with a problem. To come up with fresh insights or ideas, creative thinking can be described as logical and diverse thinking. Creativity is the end result of innovative thinking. Creativity is the entry point to creative thinking ability. If someone has high creativity then it proves

that they have the ability to think creatively [11]. The ability to reason rationally, critically, methodically, analytically, creatively, productively, draw connections, communicate, and solve mathematical problems are examples of higher order thinking skills in mathematics, also known as mathematical reasoning. One of the axes of mathematics learning is the development of creative thinking skills. In the steps of developing, finding and solving a model, or planning a problem solution, creative problem-solving skills are required [12].

Learners still need to strengthen their problem-solving skills to understand mathematics. The educational process lacks creative thinking due to two factors - program design is often material-rich. As a result, teachers who focus more on resource development than teaching strategies cannot develop their creative thinking capacity [13]. If the teacher is not active in conceptualization during the learning process, then students' creative thinking ability will not develop well. In other words, "teacher learning" is still the standard teaching technique used in schools. Such teaching, which involves conveying ideas and concepts, can hinder students' ability to develop their creativity and academic achievement. The goals and objectives of mathematics learning are no longer met by this state of affairs. Planning and methodology can influence students' potential and competence, learning goals are achieved, and achievement is attained when students are engaged in their thought processes.

Based on the description above, it can be concluded that creative thinking ability is the ability of students to draw conclusions about a mathematical problem in non-routine steps. Through creative thinking, students know how to do different things to solve math concepts from different perspectives. From the above statement, the indicators that the authors use for research are fluency, flexibility, originality, elaboration [14].

2. RESEARCH METHOD

This research is a quantitative descriptive research with a survey approach. The population of this study were junior high school students in Bengkalis Regency, Riau. The sample was a portion of junior high school students in Bengkalis Regency who were taken randomly with a cluster random sampling approach. In this case, the researcher found 2 sub-districts whose students had low creative thinking skills. Then randomize the students to describe the creative thinking ability of students in the two sub-districts. The data collection technique used is a survey technique, where the researcher provides an instrument to be filled in by the target respondent. The research instrument used is a questionnaire or questionnaire. Before the questionnaire was distributed to students, the questionnaire was validated by 3 experts and analyzed using the Aiken formula. Furthermore, construct validity is also determined to check or see whether the indicators used to measure creative thinking skills are valid or vice versa. The data analysis used in this research is descriptive quantitative, the results of which are compared with the evaluation provisions to see whether the creative thinking skills of students in Bengkalis Regency are in the very good, good, not good, and very bad categories.

3. RESULTS AND DISCUSSION

3.1 Results

The results illustrate some information such as Aiken validity, CFA first order validity results, CFA second order, and creative thinking analysis results. The results of the Aiken Validity analysis can be seen in Table 1.

Table 1. Results of Aiken's validity analysis

Aiken Validity (Content Validity) of Creative Instruments					
	Total S	V			
Item 1	8	0,89	High/Valid	Low/Invalid	0
Item 2	7	0,78	Medium/Valid	Medium/ Valid	15
Item 3	7	0,78	Medium/Valid	High/Valid	14
Item 4	7	0,78	Medium/Valid	Total	29
Item 5	6	0,67	Medium/Valid		
Item 6	7	0,78	Medium/Valid		
Item 7	7	0,78	Medium/Valid		
Item 8	8	0,89	High/Valid		
Item 9	7	0,78	Medium/Valid		
Item 10	8	0,89	High/Valid		
Item 11	8	0,89	High/Valid		
Item 12	8	0,89	High/Valid		
Item 13	8	0,89	High/Valid		
Item 14	7	0,78	Medium/Valid		
Item 15	6	0,67	Medium/Valid		
Item 16	8	0,89	High/Valid		
Item 17	9	1,00	High/Valid		
Item 18	7	0,78	Medium/Valid		
Item 19	7	0,78	Medium/Valid		
Item 20	8	0,89	High/Valid		
Item 21	9	1,00	High/Valid		
Item 22	7	0,78	Medium/Valid		
Item 23	8	0,89	High/Valid		
Item 24	8	0,89	High/Valid		
Item 25	7	0,78	Medium/Valid		
Item 26	7	0,78	Medium/Valid		
Item 27	8	0,89	High/Valid		
Item 28	8	0,89	High/Valid		
Item 29	7	0,78	Medium/Valid		

From the results of the analysis in Table 1 using three experts, it is concluded that all items or 29 items developed from four indicators are in the high/valid and moderate/valid categories, so it can be concluded that all items can be used to obtain data with some suggestions from experts.

First-Order of Confirmatory Factor Analysis

To ensure validity of expert suggestions are accurate, an analysis of CFA is needed. The

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analysis results can be seen in Table 2.

Table 2. CFA Analysis Using First-Order Confirmatory Factor Analysis

Indicators	Loading >0,3 (standardize)	Criteria
Item 1	0,60	Valid
Item 2	0,52	Valid
Item 3	0,55	Valid
Item 4	0,01	Invalid
Item 5	0,49	Valid
Item 6	-0,21	Invalid
Item 7	0,35	Valid
Item 8	0,28	Valid
Item 9	0,50	Valid
Item 10	0,44	Valid
Item 11	0,65	Valid
Item 12	0,52	Valid
Item 13	0,03	Valid
Item 14	0,54	Valid
Item 15	0,47	Valid
Item 16	0,42	Valid
Item 17	0,52	Valid
Item18	0,60	Valid
Item 19	0,49	Valid
Item20	-0,07	Invalid
Item21	0,38	Valid
Item22	-0,21	Invalid
Item23	0,18	Invalid
Item24	0,69	Valid
Item25	0,70	Valid
Item26	0,64	Valid
Item27	0,65	Valid
Item28	0,02	Invalid
Item29	0,46	Valid

Table 2. First Order CFA Report From the results of the analysis in Table 2, 6 invalid items were obtained with 1 item for the Flexibility indicator, three items for the Elaboration indicator, 1 item for the Originality indicator, and 1 item for the Fluency indicator. So, the total number of valid items is 23 items. The next stage is to know the reliability of the developed instrument. The results can be seen in Table 3.

Table 3. Instrument Reliability

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Cronbach's Alpha	N of Items
0,835	29

From the Table 3, it is acquired the Cronbach's Alpha coefficient is 0,835. It is mean that the developed instrument of 29 items have good reliability criteria.

Construct Validity

Construct validity is analysis to ensure that an indicator or construct has good validity criteria. This result can be seen in Table 4.

Table 4. Second-order CFA Report

Indicator	Loading >0,4 (standardize)	Criteria
Elaboration	0,98	Valid
Flexibility	0,98	Valid
Originality	1,05	Valid
Fluency	0,83	Valid

To ensure the reliability of the questionnaire based on the calculation results show that the P-Value = 0.0000 (>0.05), RMSEJ = 0.090 (≤0.08) and Chi-Square = 740.18 > 0.05 which means that the instruments are not valid because the P-Value is <0.05. from the data obtained, the component that gives the most significant contribution to the ability to think creatively is the Originality indicator which is 1. 05, while the smallest is Fluency at 0.83. The results showed that the assessment instrument for creative thinking skills in learning mathematics is reliable. The indicators that make up the creative variable are all valid because the loading is more than 0.4 (estimate).

Evaluation Results Based on Indicators

In this study, students were asked to fill out a questionnaire or questionnaire totaling 29 questions with a scale of SS (very often), S (often), KK (sometimes), J (rarely), and TP (never). From the data obtained, the results of the creative thinking math test are reviewed based on four indicators of mathematical creative thinking ability including:

Elaboration Indicator

Elaboration students can offer a variety of appropriate solutions for the first indicator. Based on the findings, students' mathematical creative thinking ability in this first indicator is 17%.

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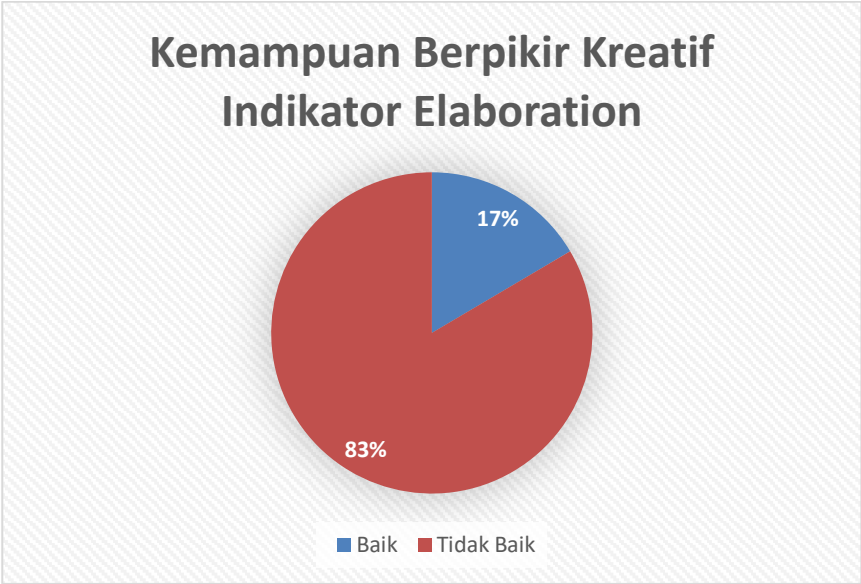

Figure 1. Elaborate Indicator Diagram

Flexibility Indicator

For the second indicator, flexibility, students can give various appropriate responses. Based on the results, students' mathematical creative thinking ability in this second indicator is 27%.

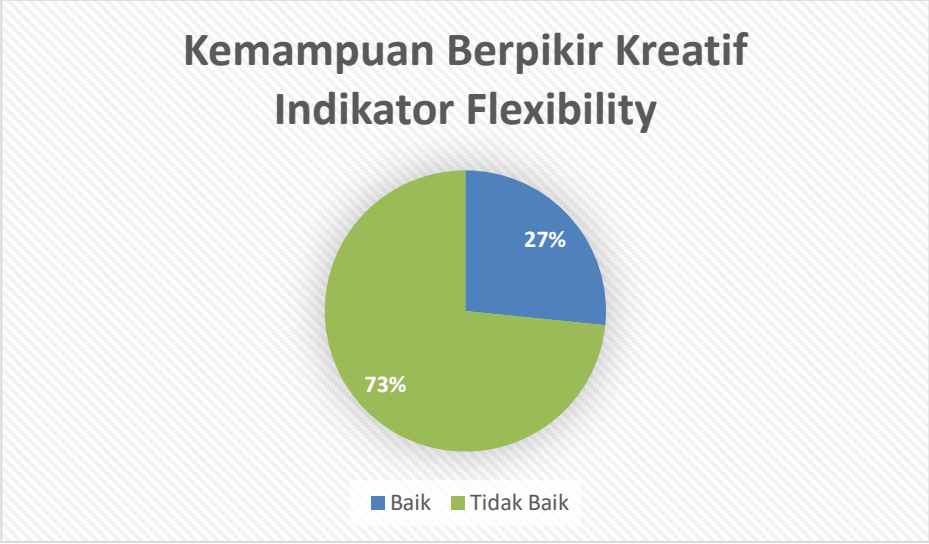

Figure 2. Flexibility Indicator Diagram

Originality Indicator

For the third indicator, originality, students can give various appropriate responses. Based on the results found, students' mathematical and creative thinking abilities in this third indicator amounted to 41%.

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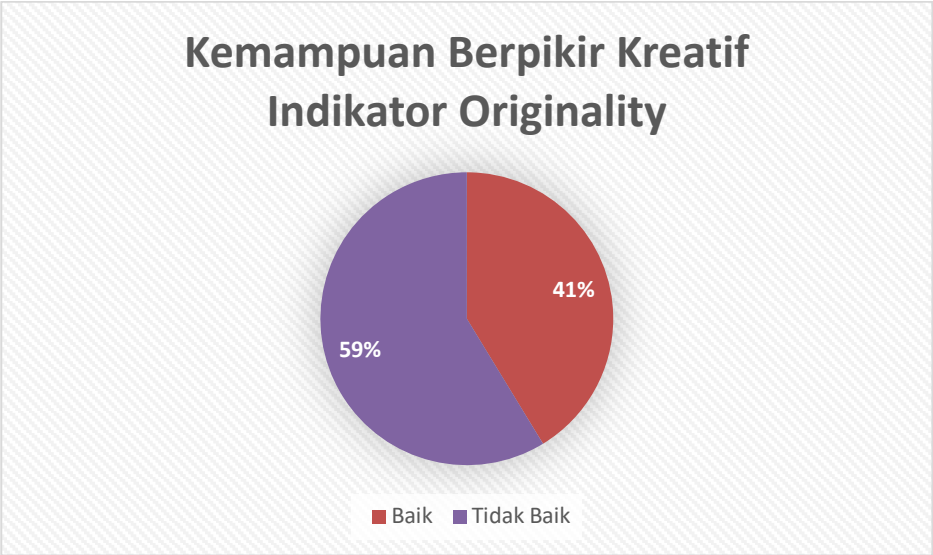

Figure 3. Originality Indicator Diagram

Fluency Indicator

For the fourth indicator, Fluency, children were competent in providing the right answers. The first indicator capturing students' ability to think mathematically innovatively based on these findings reached 35%.

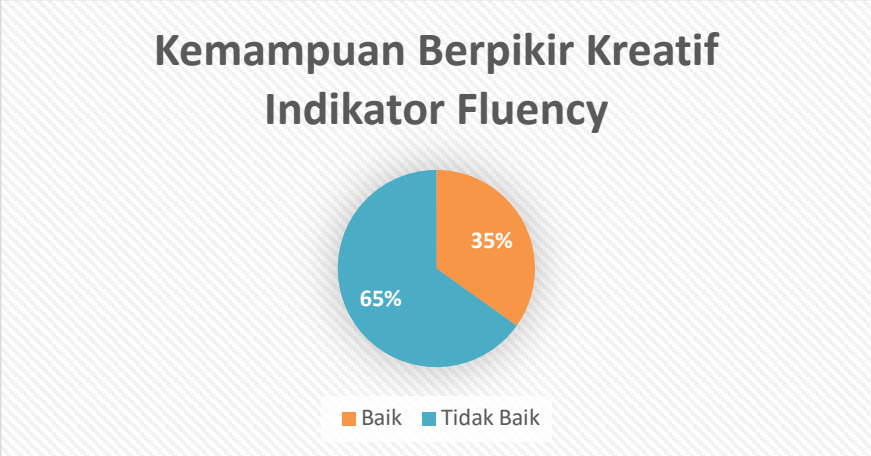

Figure 4. Fluency Indicator Diagram

Based on the findings above, the originality indicator is 41% of the questionnaire questions most frequently used by students, followed by the fluency indicator at 35%, followed by the flexibility indicator at 27%, then the elaboration indicator at 17%.

Overall Evaluation Results

The overall evaluation results illustrate some information from students' creative thinking skills based on four indicators. The overall analysis results can be seen in the figure below.

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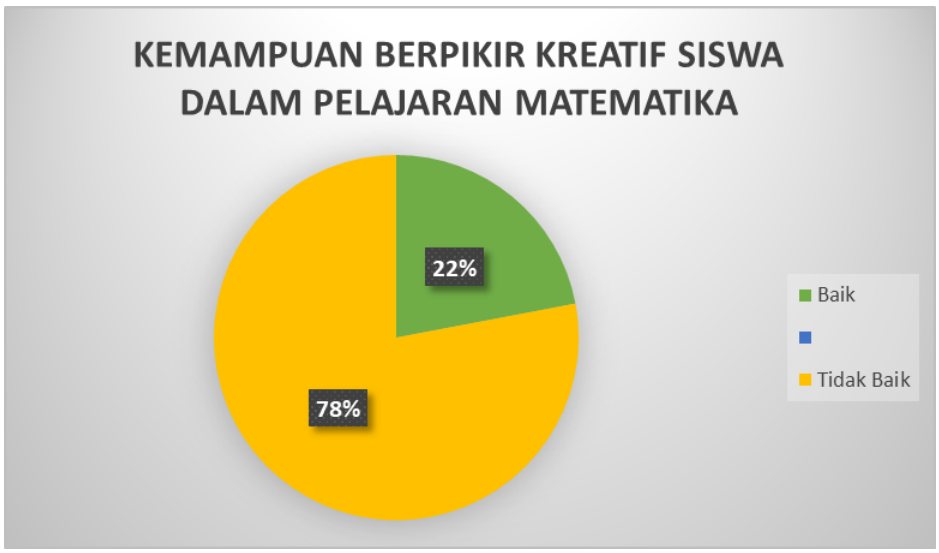

Figure 5. Overall Indicators

It can be seen from the overall results that the creative way of thinking of Bengkalis Regency junior high school students in learning mathematics is not very good, including in the category of not good. Therefore, the solution to improve students' creative thinking is that teachers should ask varied questions in the learning process or practice questions so that they can hone students' creative thinking skills.

3.2 Discussion

The results of the research analysis of student's creative thinking skills in mathematics lessons at junior high school students in the Bengkalis district are included in the category of not good. For the first indicator, namely Elaboration, the creative thinking ability of students in this indicator reaches 17%. For the second indicator Flexibility based on the results found, students' mathematical creative thinking ability in this indicator is 27%. For the third indicator, Originality, the ability of students' mathematical creative thinking in this indicator is 41% and for the fourth indicator, Fluency, the capacity of students to think original in this indicator is 35%. From the above results it can be concluded that the indicator that is most often done by students from the questionnaire instrument analyzing students' creative thinking skills in mathematics lessons is Originality, which is 41% and the Elaboration indicator has a low percentage with a value of 17%. This indicates that, students feel some obstacles in explaining an idea or describing in detail the problems in mathematics lessons [15], [16], [17]. Students' creative thinking skills were rated “poor” by 77.98% and “good” by 22.02%. Most students are currently in the bottom group for original or creative thinking skills. This is influenced by several factors, one of which is the rapid development of technology, which makes students focus on online games or things that are not useful [18]. The lack of students' critical thinking skills is also influenced by several factors, namely learning motivation, learning activities, intelligence (IQ), learning styles, and students' interest in learning [19], [20]. Learning motivation is one of the things that causes different levels of student understanding. So that learning motivation is very influential on students' creative thinking skills. A student's learning motivation is different from the others; some are high, moderate, and even low.

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In addition to students' creativity in problem solving, learning styles play an important role in students' creative thinking process [21]. One of the mathematical competencies expected at school is student competence in terms of mathematical thinking skills [22]. When it comes to developing students' original thinking while learning mathematics, the involvement of teachers is crucial. Students who are adept at creative thinking can think quickly and come up with a variety of solutions to problems. flexible thinking, which entails multiple solutions; creativity, or the capacity to ask original questions and approach problems in new ways; thinking in detail, or growing [23]. In the learning process, students' creative thinking skills will not develop effectively. Therefore, the purpose and goal of learning mathematics is no longer suitable for this situation. When students are involved in the planning and teaching process, the planning and teaching approach can affect students' potential and talents, and this achievement is achieved [24]. Students benefit from practicing diverse approaches to problem solving through creative thinking exercises. Students attempt to tackle problems in a variety of ways and at varying levels of difficulty when paths fail [25].

Since teachers do not actively encourage their students to think creatively and apply the connections between their many creative ideas and what they have learned, teachers' efforts to encourage creative thinking are modest. According to the teacher's definition of creative thinking, children doing homework for the first time usually strive to find solutions to the difficulties presented, even if their ideas are the same as those of their classmates [26]. A rational state of mind and thinking can be assessed and improved through deliberate and intentional practice [27]. The purpose of reflection is to determine the desired understanding or knowledge. While Ruggiero [28] says that thinking is a mental activity that helps in problem-solving, decision-making, and satisfying curiosity [29].

Creative thinking is thinking that tries to generate new ideas [30], [31], [32]. The concept of creative thinking is the ability to generate several possible answers to a problem based on available data or knowledge [33]. Of course, all answers must be relevant to the problem. Therefore, it is not the number of answers given that determines a person's creative thinking ability, but also the quality of the answers. Also, the answers are different. According to this point of view, creative thinking can be described as rational and divergent thinking that produces new discoveries. Besides specialized fields such as art, literature or science, creativity also occurs in many other aspects of life, such as mathematics [34]. The ability to generate original solutions to unsolvable math problems constitutes mathematical creativity [35]. The ability to produce original solutions to mathematical problems can be inferred from the two definitions mentioned above. which opens easily and flexibly, but the truth must be accepted [36], [37], [38].

The capacity for creative and mathematical thinking as a mathematical competency is divided into four parts, including fluency, flexibility, originality and elaboration. A student's ability to effectively prompt mathematical questions or problem solving is known as response fluency. Response flexibility is the student's ability to create concepts, responses, or questions that are different from the existing topic but must still be relevant. Being original is having the ability to experience a situation in a way that no one else can. The ability to elaborate allows you to develop original ideas, whether they are yours or someone else's.

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4. CONCLUSION

Previous data analysis findings show that junior high school children's creative thinking abilities are very limited. Based on a data-based investigation of junior high school students' mathematical creativity, indicators of Elaboration, Flexibility, Originality, and Fluency. Students' creative thinking abilities obtained a good category percentage of 22.02% and a bad category of 77.98%. The inability of teachers to actively involve students in the learning process and refrain from participating in the development of ideas, as well as the fact that educational techniques are still out of date, are factors that impact students' creative thinking abilities. Such education can hinder students' ability to improve and exercise their creativity, especially when communicating ideas and thoughts. Therefore, teachers must use discussion techniques and interactive learning resources more often to improve the quality of students' learning and provide the tools they need to solve problems actively and creatively.

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