

## Analysis of Creativity of Thinking in Programming Learning of Mathematics Education Students of Sulawesi Barat University

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### Abstract

*This study aims to analyze creativity in thinking in programming learning of Mathematics Education students at the University of West Sulawesi. The type of research in this study is quantitative research with a descriptive approach. The population in this study were students majoring in Mathematics Education, FKIP, University of West Sulawesi Semester III consisting of 3 class groups. The sample in this study was students majoring in Mathematics Education, FKIP, University of West Sulawesi Semester III Class A as many as 22 people. The reason the sample was chosen as a research sample was because the sample took algorithm and programming courses in Semester III. The sampling technique used in this study is random sampling. Data on student learning outcomes in programming courses were collected using performance tests and data on creativity in thinking using questionnaires. The results of the analysis of the research data obtained an average value of student programming learning outcomes of 77.5 and a value of  $77.5 > 70$  which is the standard passing value. For creativity in thinking data, an average value of 83.36 was obtained and an average percentage of creativity in thinking was 79.39% and this value is included in the high category. There are 22 samples (100%) that have creativity in thinking in the high category. Of the 22 samples that have high thinking creativity, there are 3 samples (14%) with high thinking creativity that have learning outcome values  $< 70$  and there are 19 samples (86%) with high thinking creativity that have learning outcome values  $\geq 70$ . Based on the results of data analysis, it can be concluded that samples that have high thinking creativity also have high programming learning outcomes.*

**Keywords:** Creativity of thinking; Programming; Algorithm

### 1. Introduction

Programming is one of the courses studied in the Mathematics Education Study Program. This course discusses the basics of knowledge in programming, namely algorithms, data, and variables as well as the process of computer programming stages in a structured manner. In addition, programming will also help students in solving problems in mathematics systematically and sequentially. This will of course train students' independence in learning programming.

To support student independence in learning programming, creativity in thinking is needed. Creative thinking skills are one of the important skills that must be trained in the 21<sup>st</sup> century (Auliyah, Sudiby, and Munasir, 2021). Therefore, creative thinking is considered very necessary for students in learning programming. This is supported by the results of research conducted by Afifah, Martono, and Sudarno (2019). The results of the study concluded that creativity has a direct effect on the learning process by 71%. And the results of Wahyuni and Kurniawan's research (2018) showed that creative thinking skills affect student learning outcomes with insignificant values. Sahwari and Dassucik (2020)

stated that there is an influence between creative thinking skills and learning outcomes in mathematics subjects.

Creativity in thinking will encourage students to always think out of the box so that they can always produce creative and innovative ideas. Creativity will make students look at a problem using a different perspective, so that students are able to solve problems in unique and innovative ways. By increasing the problem-solving abilities of students, student learning outcomes will also increase. This is supported by the results of research conducted by Sari and Dewi (2017). The results of their research are that creative thinking skills have a significant influence on the learning outcomes of class X IPS 1 economics subjects at MAN Mojosari. Similar research results were also produced by research

With the innovative creative thinking carried out by students, students will be able to find new solutions to do everything. Moreover, this creative thinking is very supportive in learning programming. With creative thinking, students can use all the information they have to build, combine, and develop new ideas. And this is certainly a form of higher order thinking.

The success of creative thinking in improving learning outcomes has also been proven in previous studies. Faizah, et al. (2022) conducted a study entitled Profile of creative thinking of students in mathematics subjects for grade 4 elementary school, concluding that creative thinking skills in mathematics subjects are very important for teachers to develop in several student learning activities to meet 21<sup>st</sup> century skills. The study entitled Analysis of students' creative thinking abilities through the implementation of simple electric bell making project learning (Ariani, 2023), concluded that the creative thinking abilities of class IX-C students after participating in online project learning with the help of Canva were 65.72% which was included in the good category. The next is what was done by Rosana (2020) entitled Use of Web-Based Learning in secondary schools using creative thinking strategies. The results of this study concluded that web-based creative thinking learning can improve students' creativity in solving problems. Based on the results of research from previous studies, it can be concluded that creative thinking is very important in learning because it can improve learning outcomes and the ability to solve problems. Therefore, creative thinking needs to be applied in learning.

### a. Definition of Creativity of Thinking

Sumiyatiningsih (2012: 135) states that creativity is closely related to divergent thinking patterns, meaning being able to produce alternative answers. The word "creative" comes from Latin, "creare," which means to create or produce (Dewi, 2024: 44). According to Lestari and Zakiah (2019: 2) creativity today is not only about discovery, but also includes actions and thoughts. According to the online Big Indonesian Dictionary (KBBI) (2024) creativity is the ability to create, creative power. According to Sintawati and Mardati (2023: 52) creativity is the ability to think about something in new and unusual ways and produce unique solutions to problems. Uloli (2021: 15) Creativity is an active process that needs to be involved in innovation.

According to Nurlaela and Ismayati (2015:3), creative thinking has the characteristics of fluency, flexibility, originality. A similar opinion was also expressed by Lestari (2017:89), according to her, the indicators of creative thinking are; 1) fluency, 2) flexibility, 3) originality, and 4) elaboration. According to Nur, et al. (2021) creative thinking is a process of constructing ideas that emphasizes aspects of fluency, flexibility, novelty and detail. Based on these indicators, creative thinking will encourage students to produce creative ideas, thoughts, or concepts to solve the problems they face. These ideas are then realized and produce or create products that have authenticity or originality values. A further explanation of the creativity indicators can be seen in the following table.

**Table 1. Creativity Thinking Indicator**

No	Indikator	Deskripsi
1.	Fluency	The ability to produce many correct ideas or thoughts.
2.	Flexibility	Generating diverse ideas or concepts, seeing a problem from different perspectives.
3.	Originality	Thinking of new ideas that are unique and unusual, or unconventional.
4.	Elaboration	The ability to describe something in detail.

Source: Nurlaela and Ismayati (2015:3)

With creative thinking, students will be able to see problems as challenges and try to see them from various perspectives. Students will think and build ideas and concepts. According to Firdaus, Asikin and Agoestanto (2021) Students who have relatively high creative thinking skills will find several ways or alternatives to solve the answers to the problems they are looking for and are different from other students. Students will then try to realize these ideas through trial and error activities to solve problems and provide alternative solutions to the problems faced. By being able to find solutions to this problem, this of course then increases students' ability to solve problems (problem solving).

### b. Characteristics of Creative Thinking

The characteristics of creative thinking possessed by a person are as follows: having great curiosity, being independent, thinking flexibly, liking to try new things, being skilled. According to Susanti et al. (2022:34) the characteristics of creative thinking possessed by a person are as follows: 1) creative thinking, 2) open thinking, 3) risk taker, 4) knowledge, the knowledge possessed will be able to encourage creative thinking, and 5) flexible. According to Diharto (2022:27) the main characteristics of creativity are generating ideas, concepts, inspiration, solutions, new ways, discoveries.

According to Sit, et al. (2016:9) behavioral characteristics that reflect creativity are as follows; 1) enjoy exploring their environment, 2) explore expansively and excessively, 3) have great curiosity, 4) are spontaneous, 5) like to be adventurous, 6) like to experiment, 7) rarely feel bored, and 8) have high imagination. Creative thinking is thinking differently from others (Susanti, et al., 2022:72).

## 2. Method

The research method used in the study is quantitative research with a descriptive approach. According to Sugiyono (2012:13) it is also called a quantitative method because the research data is in the form of numbers and analysis using statistics. According to Ilyas, et al. (2015:76) quantitative research has characteristics related to numerical data and is objective.

This research was conducted at the Mathematics Education Study Program, University of West Sulawesi in the odd semester of the 2024/2025 Academic Year. The subjects of this study were 22 students of the Mathematics Education Study Program, FKIP Unsulbar, Semester III Class A.

Data collection techniques in this study were carried out using performance tests and questionnaires. Performance tests were used to collect data on programming learning outcomes and questionnaires were used to collect data on thinking creativity. The thinking creativity research questionnaire consisted of 21 statement items with 5 (five) answer options, namely Strongly Agree (SS), Agree (S), Undecided (R) or Neutral, Disagree (TS), Strongly Disagree (STS). The questionnaire was measured using a Likert scale of 5, 4, 3, 2, and 1.

Then an analysis was carried out to calculate the average value of the student's programming learning outcome data and the value of the results of the thinking creativity questionnaire. The maximum score that can be achieved in the test is 100 and the minimum score is 0. The average score of students is calculated using the following formula.

$$\text{Average value} = \frac{\text{Total score of all students}}{\text{Number of students}}$$

The percentage value of learning completion is calculated using the following formula.

$$\text{Completeness} = \frac{\text{Number of students who achieved KKM}}{\text{Number of students}}$$

The learning completion criteria are as follows:

>80%	= Very high
60% - 79%	= High
40% - 59%	= Medium
20% - 39%	= Low

0% - 19% = Very low

The questionnaire data analysis was conducted by calculating the acquisition score for each questionnaire item. Then the student questionnaire acquisition score was calculated in the following manner.

Maximum value = Maximum value of selected answer options x number of questionnaire items  
 = 5 x 21  
 = 105

Minimum value = Minimum value of selected answer options x number of questionnaire items  
 = 1 x 21  
 = 21

The percentage of the achievement of the creativity thinking questionnaire score is calculated by comparing the score obtained with the maximum score and then multiplied by 100%. For more details about the percentage formula for the achievement of the creativity thinking questionnaire score, it can be seen in the following formula.

$$\text{Percentage of questionnaire score} = \frac{\text{Acquisition value}}{\text{Maximum value}} \times 100\%$$

Based on the maximum and minimum values obtained from the questionnaire, creativity in thinking is categorized into 3 (three) categories, namely high, medium, and low. The determination of the category range for each category is determined as follows.

High category  $76 \leq x \leq 105$

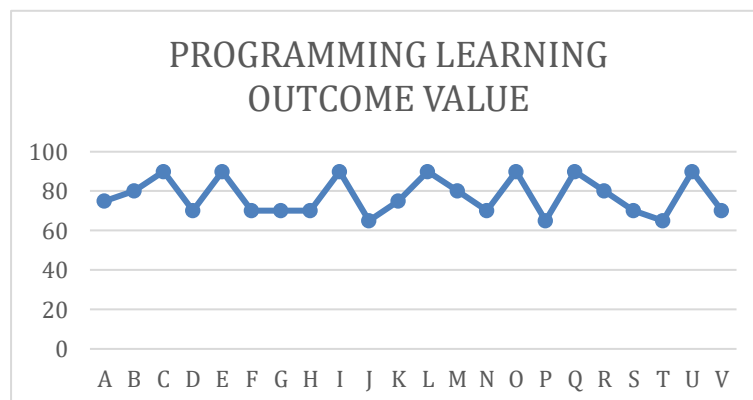
Medium category  $48 \leq x \leq 75$

Low category  $20 \leq x \leq 47$

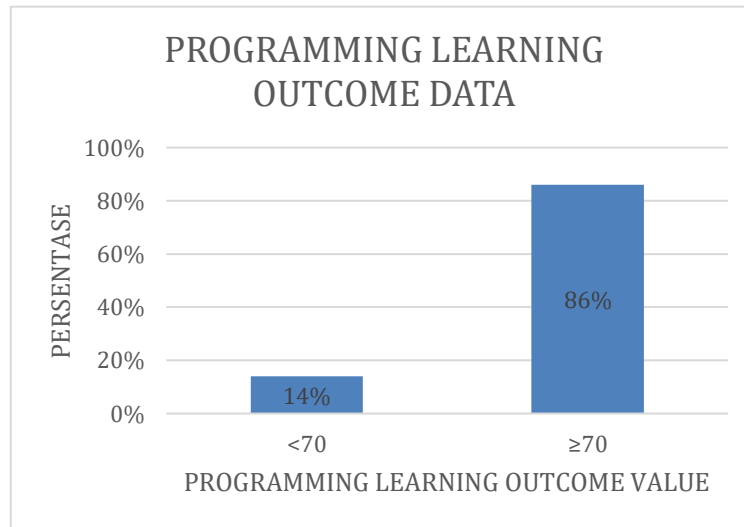
### 3. Results and Discussion

#### Results

The average value of students' programming learning outcomes obtained after analyzing the research data was 77.5. The highest value of students' programming learning outcomes was 90 and the lowest value of students' programming learning outcomes was 65. There were 3 samples (14%) that obtained programming learning outcomes <70 and there were 19 samples (86%) that obtained programming learning outcomes  $\geq 70$ . And the completion value was 86%. The presentation of data for programming learning outcomes is shown as follows.

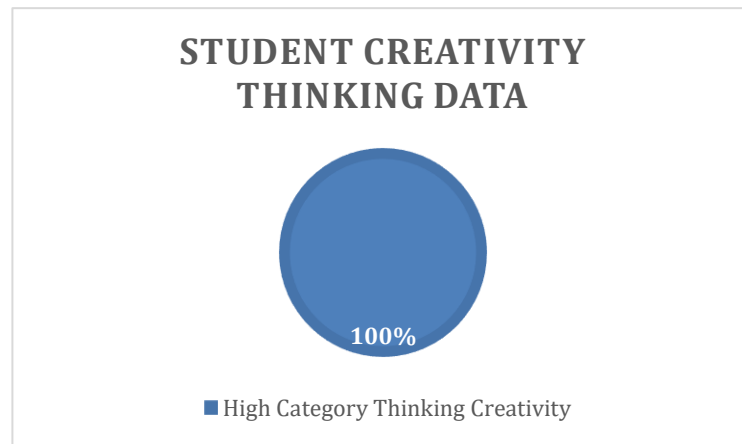


**Figure 1. Programming Learning Outcome Data**



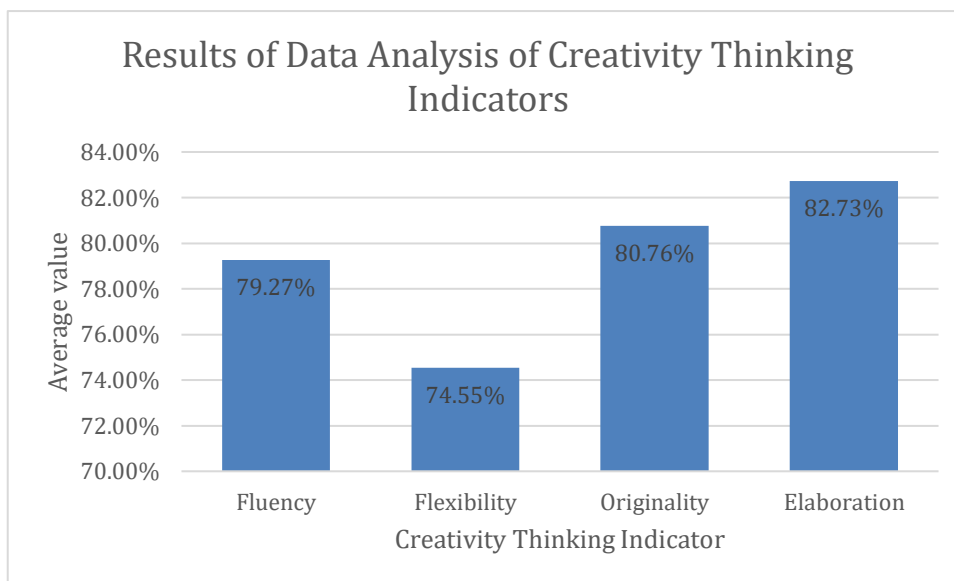
**Figure 2. Categorization of Programming Learning Outcome Data**

And for the value of the questionnaire data of thinking creativity, it was found that the highest value was 95 and the lowest value was 72 with an average value of the questionnaire data acquisition of 83.36 and the percentage of the average value of thinking creativity was 79.39% and this average value is in the high category. Based on the results of the analysis of the thinking creativity questionnaire data, 22 samples (100%) were obtained who had high category thinking creativity. The presentation of data for the thinking creativity value can be seen as follows.



**Figure 3. Acquisition of Creativity Thinking Data**

Based on the data in Figure 3. Data Acquisition of Thinking Creativity, an analysis was carried out on each indicator of thinking creativity, namely fluency, flexibility, originality, and elaboration. The results of the data analysis for the fluency indicator obtained a total percentage value of 1,744 and an average value of 79.27% in the high category. The results of the data analysis for the flexibility indicator obtained a total percentage value of 1,640 and an average value of 74.55% in the medium category. The results of the data analysis for the originality indicator obtained a total value of 1,777 and an average value of 80.76% in the high category. And for the elaboration indicator, a total value of 1,820 and an average value of 82.73% were obtained in the high category. The presentation of the results of the thinking creativity data analysis can be seen as follows.



**Figure 4. Results of Data Analysis of Thinking Creativity Indicators**

## Discussion

The results of the data analysis concluded that there were 22 samples (100%) that had high category of thinking creativity. Of the 22 samples that had high thinking creativity, there were 3 samples (14%) with high thinking creativity that had learning outcome values  $<70$  and there were 19 samples (86%) with high thinking creativity that had learning outcome values  $\geq 70$ .

Based on the results of the research data analysis, it can be concluded that there are 19 samples (86%) with high thinking creativity who have learning outcome scores  $\geq 70$ . This of course shows that 86% of students who have learning outcome scores  $\geq 70$  are students who have high thinking creativity. This proves that students with high thinking creativity also have high learning outcome scores.

The results of this study are also supported by the results of previous research conducted by Safaria and Agus (2024) entitled *The Exploration of Mathematical Creative Thinking Ability in Solving Geometry Problems from the Perspective of Mathematical Ability*. The results of this study indicate that junior high school students with high mathematical abilities show creative thinking in solving geometry problems, and vice versa. This means that students with lower creative thinking have low mathematical abilities. Research by Sandianita, Indriyanti, and Mulyani (2018) also found that there is a significant relationship between creativity and learning achievement.

Based on the results of the research findings, it can be seen that high creativity in thinking has a very positive contribution in determining the results of students' programming learning. The positive contribution and the large contribution of creativity in thinking to the results of students' programming learning is because with creativity in thinking, it encourages students to explore and unite all the ideas, information, thoughts, imaginations that they have. Then they draw one by one the red thread that can connect all the information they have to be used in understanding and comprehending the problems faced.

The positive contribution and the large contribution of creative thinking to the results of students' programming learning is because with creative thinking, it encourages students to explore and unite all the ideas, information, thoughts, imaginations that they have. Then they draw one by one the red thread that can connect all the information they have to be used in understanding and comprehending the problems faced.

After they find a common thread or relationship between one piece of information and another, students can analyze data, develop concepts, make observations, synthesize, and combine combinations that have never been done before. Creative thinking will make students form a new relationship through

logical thinking. This activity will continue to be carried out until students find the right combination or the right answer to the problem they are solving.

Based on the analysis of students' creative thinking data for the fluency indicator, an average value of 79.27% was obtained in the high category. Fluency includes the ability to generate ideas or concepts. With high creative thinking, students can express new ideas or concepts. Creative thinking encourages students to always think out of the box, so this will make students develop new ideas and be more able to improvise. By being more open to new ideas and improvisation, students can have a deeper understanding of the problems they face and can determine hypotheses for these problems and ultimately explore to prove these hypotheses.

Based on the analysis of students' creative thinking data for the flexibility indicator, an average value of 74.55% was obtained in the moderate category. Flexibility includes the ability to express various alternative solutions, answers, and approaches to a problem. This ability encourages students to provide a description of a situation and organize these situations. Based on the results of the data analysis, the students obtained a flexibility value in the moderate category, meaning that the students were still unable to apply flexibility in creative thinking optimally. Students still have limitations and shortcomings in expressing the ideas and concepts they have. The students were still unable to provide views and approaches that can be used in solving problems. They were still unable to provide alternative solutions to solving problems optimally. This was identified because of the limited access that students had in accessing information.

The limited access to information here includes the lack of library resources available in the library facilities on campus. In addition to the lack of library resources, limited internet access on campus is also one of the factors causing students to still not be flexible in thinking creatively. With the lack of information owned by students, this makes them have very little data or materials that can be used as a basis for creating and building solutions to solve a problem they are facing.

In addition to limited access to information which is a factor causing the flexibility of creative thinking of students in the moderate category, another factor is the low ability of students to find approaches and solutions that can be used as solutions in solving problems. Students have not been able to understand the situation and conditions of the problems faced. This causes students to have difficulty in finding and creating alternative solutions to approaches to solving the problems being faced.

Based on the analysis of students' creativity thinking data for the originality indicator, an average value of 80.76% was obtained in the high category. Originality is the ability to produce new things. Based on the results of the analysis, the originality value of students' creativity thinking was obtained in the high category. This means that students are able to solve a problem in new, unique, and different ways from existing ones.

Based on the analysis of students' creativity thinking data for the elaboration indicator, an average value of 80.76% was obtained in the high category. Elaboration is the ability to describe something in detail. Based on the results of the analysis, students have an elaboration value in the high category, meaning that students have the ability to solve problems by applying predetermined procedures. With algorithmic thinking, this encourages students to be able to solve problems systematically and in detail and in accordance with procedures and details.

#### 4. Conclusion

The conclusion can be a generalization of the findings according to the research problem, or it can be in the form of a recommendation for the next step.

The conclusion in this study is that samples that have high thinking creativity also have high programming learning outcomes. This conclusion is based on the data on the average value of students' programming learning outcomes of 77.5. Of the 22 samples, there were 3 samples (14%) that got programming learning outcomes  $<70$  and there were 19 samples (86%) that got programming learning outcomes  $\geq 70$  which is the standard passing grade. The average value of the questionnaire data for thinking creativity was 83.36% and this value is included in the high category, and there were 22 samples that had high thinking creativity (100%).

The 3 samples (14%) that obtained programming learning outcomes  $<70$  could be influenced by other variables, namely variables other than creative thinking, which were not discussed in this study,

such as IQ, gender, and parental income level. Based on this, lecturers can consider creating learning that can stimulate and improve thinking creativity, because empirically it has been proven that thinking creativity has a positive and significant contribution to students' programming learning outcomes.

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