Students' Creative Thinking Skill in Solving the Divergent Problem: Case Study in Junior High School in Nusa Tenggara Timur, Indonesia

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***Abstract*—Mathematics learning in the classroom requires the teacher to need to design a learning plan that can develop students 'creativity, but before that the teacher must first know the extent to which students' creativity and how to measure that creativity. This study aims to describe students 'creativity in solving divergent problems based on students' mathematical abilities. The subject of this quantitative descriptive study was 72 students selected: 12 high-ability students, 19 moderate-capable students and 41 low-ability students. Then they were screened to 9 students each with three high-ability students, three students with moderate abilities and three low-ability students. The procedure of this study consists of the stages of preparation, implementation, data analysis, and preparation of reports. The instrument of this study consisted of the main tools, namely the researchers themselves and supporting devices, namely the math ability test questions, divergent questions, and interview guidelines. The results showed that subjects with low mathematical abilities did not fulfill the three indicators of creativity, so they were at a level, not creative. Moderate questions only achieve fluency indicators, so they are at a less elementary level. High-ability subjects meet signs of fluency and flexibility, so they are at the creative level.**

Keywords—creative thinking, ability to solve questions, divergent questions

I. INTRODUCTION

Efforts to improve Indonesia's human resources need to be continuously developed. Human resources that can meet the above challenges are those who, among others, can think critically, logically, systematically, and creatively so that they can face various challenges of living independently with confidence. The initial goal of education is not to train individuals who repeat the previous generation but to train generations of inventors who can produce new and creative things [1], [2]. According to Setiawan, one aspect that must be improved in the vision of national education is creativity that includes the ability to create new combinations or see new relationships between elements or things that already exist [3], [4]. Creative thinking means trying to solve a problem by involving all the looks and facts of processing data in the brain. The opinions of experts and researchers above want learning to lead to understanding the concepts needed to solve other scientific problems. The development of one's mathematical creative thinking skills is not an easy job. This work requires perseverance, practice, and long-lasting and continuous destruction. Likewise, in learning, the development of creative thinking takes a long time.

II. THEORETICAL BACKGROUND

A. Creativity in Mathematics

The optimal development of the ability of creative thinking is closely related to the way teachers teach, creative thinking skills grow well if students learn on their initiative, give them the confidence to think and dare to present new ideas. Student creativity will grow if trained to do exploration, inquiry, discovery and solving problems [5], [6]. Maintaining the Integrity of the Specifications.

In the field of mathematics, creativity is often associated with solving and submitting problems. But in this study, researchers only linked creativity with solving mathematical problems. Creativity in mathematics is different from creativity in other fields, according to [7], [8]. Creativity in mathematics is defined as the ability to see or choose solutions in mathematics; creativity in the context of mathematics is an extraordinary ability to produce new solutions and is useful for solving problems in real life using mathematical modeling.

Fluency, flexibility, and novelty are three crucial aspects of creativity [9], [10]. Fluency aspects refer to the truth and diversity of answers given by students. Flexibility aspects relate to the different ways provided by students in solving problems, while elements of novelty refer to the answers given are not unusual for the level of knowledge of students in general or can also refer to new ways displayed by students. The original method can be a way of combining the experience gained by the previous student.

Experts have researched how to measure creativity [6], [11]. Measures creativity by using divergent thinking ability tests. The test contains verbal and non-verbal questions and in the form of problem-solving. Other experts are [6], [10]. He created TTCT (The Torrance Test of Creativity Thinking). TTCT consists of verbal and visual tests. Both tests to measure one's creativity still refer to the three aspects, namely fluency, flexibility, and novelty. TTCT was then widely adopted by mathematicians as a measure of one's mathematical creativity.

The ability to think someone has a level according to work produced by that person. Table I shows the Level of Creativity [12].

B. Divergent Mathematical Problems

Problems are relative for each. According to [12], the characteristics of an issue are: 1) individuals realize/ recognize a situation (questions) faced. In other words, individuals have prerequisite knowledge; 2) Individuals know that the position requires action/action. In other words, challenging to solve,

and 3) steps to solve a problem do not have to be bright or quickly captured by others.

TABLE I. THE LEVEL OF CREATIVITY

Level 4 (very creative)	students can show fluency, flexibility, and novelty or new flexibility in solving problems
Level 3 (creative)	students can demonstrate fluency and novelty or fluency and flexibility in solving problems
Level 2 (quite creative)	students can show novelty or flexibility in solving problems
Level 1 (less creative)	students can show novelty or flexibility in solving problems

In other words, the individual already knows how to solve the problem even though it is not yet clear. The characteristics of the issue include: 1) the problem must be meaningful, entertaining, and practical; 2) the problem can be defined; 3) have educational value; 4) it is better if the problem is related to students' daily issues; 5) the problem has a relationship with the material that the student has received before; 6) the item should be in accordance with the mental and physical development of students; 7) the problem can develop students' imagination and critical strength; 8) these problems can develop mathematical abilities, and 9) these problems can improve students' scientific sense [13].

Divergent questions have a settlement step that students cannot directly know so that students need higher order thinking [14]. Creativity is always related to one's ability to think divergently [7], [15]. Has proven this by making a measuring tool of one's creativity by using divergent thinking ability tests. Creativity indicators are also related to divergent thinking. Explains that the criteria of assignments in the aspect of creative thinking must be different in both the answers and the solutions. This is because the task must be able to bring up the three indicators of creativity [12], [16].

So, in this study, it can be concluded that divergent mathematical problems are mathematical questions/problems whose completion procedures cannot be directly used to find the answers to these questions and allow them to have different ways of solving them and have different answers.

C. Mathematical Ability

Bloom explains that there are four kinds of knowledge, namely factual experience, conceptual understanding, procedural knowledge, and metacognitive knowledge. Accurate knowledge is the knowledge that contains essential elements in science. Theoretical knowledge is the knowledge that shows the interrelationships of crucial elements with more substantial structures. Procedural knowledge is knowledge about how to do things (algorithms). Metacognitive awareness is knowledge of cognition in general and understanding of oneself; for example, one's perception of general strategies in thinking and solving problems. This knowledge also applied in mathematical disciplines, so that a person's mathematical abilities can be measured by this knowledge.

This mathematical ability is closely related to students' creativity in solving mathematical problems. Mathematical creativity followed by students' prior knowledge of mathematics [15], [16]. Therefore in this study, researchers measured students' mathematical abilities based on two things namely procedural knowledge and conceptual understanding. Factual and metacognitive expertise is not used in this study because there are no types of questions in the National Exam questions to measure both bits of knowledge. Students 'mathematical abilities are measured using tests that have learning indicators taken by students and can measure students' knowledge of conceptual understanding and procedural knowledge in mathematics. In the selection of questions, the researcher adopted the 2013 National Examination National Exams questions until 2017.

From various opinions it can be concluded that the creativity of students will be born and develop in learning that presents non-routine problems as a stimulus, free of expression in exploring, discovering, learning in small groups, and solving problems. The teacher must first know how far the creativity of his students and how to measure the creativity, the purpose of the study is to analyze the ability of students to think creatively in solving divergent problems, to obtain a description of the creativity of students who are low-ability, modest, and highly capable.

III. METHOD

A. Research Context

This method used in this study is a qualitative approach because the data from this study are in the form of descriptions. The procedure in this study consisted of 4 stages, namely the preparation stage, the implementation phase, the data analysis phase, and the report preparation stage. At the preparation stage, the researcher agrees about the time and class that will be used for research and preparation of instruments, namely tests of mathematical abilities, divergent mathematical problems, and interview guidelines. The interview analysis is divided into three parts, namely, reduction, presentation, and conclusion.

B. Research Procedures

The procedure in this study consisted of 4 stages, namely the preparation stage, the implementation phase, the data analysis phase, and the report preparation stage. At the preparation stage, the researcher agrees about the time and class that will be used for research and preparation of instruments, namely tests of mathematical abilities, divergent mathematical problems, and interview guidelines. The interview analysis is divided into three parts, namely, reduction, presentation, and conclusion. The last stage is the report preparation stage. Reports are prepared based on the results of data and the results of data analysis conducted by researchers. The results described by researchers in the report are descriptions of the creativity of students of the Madrasah Tsanawiyah Muhammadiyah Wuring in solving divergent mathematical problems based on indicators of creativity.

C. Population and Sample

This research was conducted for three months starting from August 2018 at the Muhammadiyah Wuring Islamic Primary School in Sikka district, Flores, East Nusa Tenggara. The research subjects were grade IX students at the Muhammadiyah Wuring Islamic School, which numbered

nine people, namely three highly skilled people, three modest-capable people, and three low-ability people.

D. Instruments

Mathematical ability test material includes accurate material namely algebraic forms, relations and functions, straight line equations, two-variable linear equation systems, and Pythagorean theorems which are then consulted by lecturers and subject matter teachers. The question in the ability test of the researcher is the adaptation of the items from the SMP National Examination from 2013 to 2017. The questions on the math ability test consist of 10 multiple choice questions that are answered with descriptions. The researcher makes a question that is answered with an explanation to find out the students' procedural abilities. The next instrument is divergent mathematical problems. Different mathematical challenges in this study consist of one question that covers the material that has been studied before students, namely the area of the flat building, Pythagoras theorem, discounts, and scale and comparison. The third instrument is the interview guide. The interview guide was used as a reference from interviews conducted by researchers to each research subject.

Making interview guidelines refers to the three creativity indicators used in this study, namely fluency, flexibility, and novelty. Interviews are conducted to clarify students' thinking processes, such as the strategies used and cannot be expressed in writing. Divergent math problems and interview guidelines were then validated by a mathematics lecturer and a Mathematics teacher. The next stage is the implementation stage. The research began with data retrieval of mathematical abilities using an accurate ability test instrument.

The math ability test results were then sorted and grouped into three groups, namely the low ability group (student score less than 60), moderate ability group (student score between 60 and 80), and high ability group (student score higher than 80). After that, the subjects were interviewed one by one by the researcher. The interview was conducted on the same day by working on divergent mathematical problems because to avoid the question forgetting the strategies he used in solving the problems given. To check the validity of the data, the researcher uses source triangulation which compares and corrects the degree of trust in information obtained through different time and tools [13].

E. Data Analysis

The next stage is the data analysis stage. Analyzing data in this study is divided into 2, namely written data analysis and interview data analysis. Analysis of written data is an analysis of divergent mathematical problems. Analysis of different mathematical problems is based on three indicators of creativity, namely fluency, flexibility, and novelty.

Data collection research conducted at Madrasah Tsanawiyah Muhammadiyah Wuring using tests and interviews. Data analysis is a data management activity so that it can be easily understood and can be used in problem-solving or describing phenomena that are examined. In this study, the data analysis method used is descriptive qualitative; this is to describe the state of the subject based on objective data.

IV. RESULT

The initial stage of the research was by conducting a scientific ability test of the material Geometry given to 73 students of class IX MTs Muhammadiyah Wuring, but one student did not enter because of illness so, this ability test was only given to 72 students. Based on the above groupings, there were 12 students in the high ability group, 19 students in the moderate ability group, and 41 students in the low ability group. The results of the discussion with the mathematics teacher obtained the nine research subjects as Table II.

TABLE II. THE ABILITY PROFILE

Level of Ability	No	Subject Name	Value
Low Ability	1	FIN	55
	2	ES	55
	3	PR	55
Modest ability	4	FAN	65
	5	D	65
	6	NSY	65
High Ability	7	KR	80
	8	SH	80
	9	YI	80

A. Creative Thinking Abilities Subject FIN, ES, PR (Low Ability) in Resolving Divergent Questions

Written results and interviews from data collection have similarities. The subject FIN, ES, PR lacked understanding of the mathematical concepts he had received, namely the flat plane, the Pythagorean theorem, and discounts. This finally affected FIN, ES, PR creativity in solving divergent mathematical problems that had been given. Based on the results of the data analysis above, the subject FIN, ES, and PR, cannot fulfill the three indicators of creativity, namely fluency, flexibility, and novelty. In the process of solving divergent mathematical problems, the subject of this low mathematical ability does not have a specific strategy to achieve a solution to the question, besides that the issue also gives up quickly when he encounters something that makes him suffer. Based on TKBK by [8], the subject of FIN, ES, and PR is at the level of not being creative.

B. Subject Creative Thinking Ability KR, SH, YI (High Ability) in Solving Divergent Questions

Written results and interviews from data collection illustrate similarities. Subject KR, SH, and YI have understood the concept of the flat wake, Pythagorean theorem, and discounted material. However, KR, SH, and YI were not careful enough so that there were many inappropriate jobs. This finally influenced the creativity of KR, SH, and YI in solving the divergent mathematical problems that had been given. Based on the results of the data analysis above, the subjects KR, SH, and YI can meet the indicators of fluency and flexibility while the novelty indicator is not fulfilled. In the process of solving divergent mathematical problems given, this subject with high mathematical abilities has used the right strategy. But because often the issue does not recheck the answer, then there are some errors in the quality of the subject because it is not thorough. Questions KR, SH, and YI were at the creative level.

The research relevant to the results that creativity is a different intelligence. Children who score high on intelligence tests are not always very creative [17], [18]. This study

provides empirical evidence that creative thinking skills are independent of achievement levels, whether high achievement or low. students have different levels of creative thinking. This study uses a qualitative approach that describes the characteristics of students' creative thinking in mathematics [19]. There are nine students from Sidoarjo Public Middle School 6 showing five levels of creative thinking from level zero to level four having different characteristics. Divergent thinking skills play an essential role in achieving math problems [20]. There are significant differences between students who think divergently and students who do not use different modes of thinking in solving mathematical problems.

V. CONCLUSION

The creativity of subjects with low mathematical abilities is at the level of not being creative. In the process of solving divergent problems given, the issue does not have a specific strategy and is easy to give up if he starts to find difficulties in working on the problem. For creativity, subjects with mathematical abilities are at a less creative level. In the process of problem-solving, the issue often calls the method used is a logical method. This method is correct in determining the resolution of a given problem, but because the strategy is not associated with the information that students have obtained beforehand so that the resulting solution is still not right. Furthermore, for creativity, subjects with high mathematical abilities are at the creative level. In the process of solving the problem, the issue has used the right strategy, but there are some errors in the execution of the subject because it is not thorough and the item does not recheck the answer.

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