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Analysis of Mathematical Creative Thinking Ability in Problem-Solving in Terms of Adversity Quotient

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Abstract: *This study aimed to analyze mathematical creative thinking skills in problem-solving in terms of the adversity quotient. This research is a qualitative descriptive study. It was conducted on 23 third-semester students of Tarbiyah Faculty at Ibrahimy University. The data were collected using a questionnaire, test, interviews, and documentation. The questionnaire was used to determine the Adversity Quotient scale. The test is to measure the students' mathematical creative thinking ability. The test results were used to divide the students into three groups based on their ability level. Two students were selected from each group to be interviewed. Data analysis was induction and data reduction theory. The results of the Adversity Quotient scale questionnaire showed that there were 6 students (26%) with the quitter type, 14 students (61%) with the camper type, and 3 students (13%) with the climber type. The test results showed that there were 8 students (35%) with high abilities, 11 students (48%) with moderate abilities, and 4 students (17%) with low abilities. The analysis showed that the fluency criteria of students with the quitter type meet three problem-solving indicators. The students with flexibility criteria in the camper type met all problem-solving indicators but lacked detail. Meanwhile, the students with originality criteria in the climber type could fulfill all problem-solving indicators in detail.*

Keywords— *Mathematical Ability, Creative Thinking, Thinking Skills, Problem-Solving, Adversity Quotient.*

1. INTRODUCTION

The learning process in the 21st century aims to make students master critical thinking, problem-solving, creativity, innovations, communication, and collaboration skills [1]. The teaching and learning process is one of the efforts to improve and develop creativity in educational instruction [2]. Mathematics is one of the essential subjects in education. Mathematics learning is learning that emphasizes more on solving mathematical problems [3]. The expected problem solving is that it involves and trains creativity [4]. Creative thinking skills can be analyzed when students are in the problem-solving process. The indication is when students can provide alternative answers and varied strategies, the uniqueness of the solutions offered, and the details of the answers presented [2].

Polya defines problem-solving as an effort to find solutions to difficulties, achieving goals through logical efforts [2]. According to Lencher, mathematical problem solving is the process of applying mathematical knowledge that has been previously acquired to new, unfamiliar situations [5]. Hobri concluded that problem-solving is the most complex level of individual cognitive activity that requires efforts to solve problems involving all parts of the individual's intellectual property, namely memory, perception, reasoning, conceptualization, language, emotion, motivation, self-confidence, and the ability to control situations [1]. Naja states that NCTM formulates five standard mathematics learning processes: problem-solving, reasoning, communicating, making connections, and presenting [4]. Meanwhile, the steps for solving problems in mathematics, according to Polya, consist of four main steps: understanding the problem, making plans to solve the problem, carrying out problem-solving, and re-examining the answers obtained [6].

In solving mathematical problems, mathematical creative thinking skill is necessary. Creative thinking, according to Nazareth, can be defined as a student's ability to generate many possible answers and ways to solve problems [7]. According to Tohir, It is one of the essential thinking skills for students to have a more meaningful learning experience and improve their thinking skills in solving everyday problems [8]. In this study, in line with Fauziah and Febriyanti, creative thinking ability is measured using three criteria for creativity: fluency, flexibility, and originality [9, 10]. Fluency refers to a student's ability to produce varied and correct answers to a given problem. Flexibility refers to a student's ability to propose various ways to solve problems. The last, Novelty (originality), refers to the ability of students to answer problems with different answers and correct values or one answer that students do not usually do at their level of development [11].

Student responses to problem-solving problems are different. Some students feel challenged, and others give up on solving the problems they face. A person's ability to turn the problems he faces into challenges that must be solved as well as possible is called Adversity Quotient (AQ) [2]. Adversity Quotient (AQ) was introduced by Paul G. Stoltz, AQ, it used to assess the extent to which a person faces a complex and challenging problem and even turns it into an opportunity [3]. According to Stoltz (in Ra'is), AQ is a person's intelligence in responding to adversity and the survival ability, as well as to measure a person in viewing problems as an obstacle or persisting in facing problems until success is accomplished on the problem [12]. Nurlaeli argues that the Adversity quotient is a person's ability to observe difficulties and process them with intelligence so that it becomes a challenge to solve them [13]. Adversity Quotient (AQ) is a form of intelligence other than IQ, SQ, and EQ, intended to survive in difficult situations [14]. Stoltz classifies Adversity Quotient into 3 categories, namely:

low AQ (quitter), moderate AQ (camper), and high AQ (climber) [15]. In more detail, Stoltz states that Quitters tend to reject the existence of existing challenges and problems; Campers have a limited ability to change, especially major changes. They accept change and propose some great ideas but only as long as they are in their safe zone; Climbers are individuals who can be relied on to make changes because the challenges offered make individuals grow because they dare to take risks and overcome fears [16].

The explanations inferred that mathematical creative thinking ability is essential to problem-solving. Moreover, the adversity quotient becomes a motivation in facing problem-solving as a challenge. Thereby, with the adversity quotient approach, it is expected that the problem can be solved by students appropriately and optimally. Thus, this study aims to analyze mathematical creative thinking skills in problem-solving in terms of the adversity quotient.

2. RESEARCH METHODS

This research is a qualitative descriptive study. The method used is a case study, which is part of a qualitative method that wants to explore a particular case in greater depth by involving the collection of various sources of information [17]. The research was conducted on third-semester students of Tadris Mathematics, Faculty of Tarbiyah, Ibrahimy University. The case to be explored in this research is mathematical ability in problem-solving in terms of the adversity quotient.

Data were collected using questionnaires, tests, interviews, and documentation. The questionnaire was used to determine the Adversity Quotient scale, which was divided into three categories, namely: low AQ (quitter), medium AQ (camper), and high AQ (climber). The test was to measure the students' mathematical creative thinking ability. According to the test results, students are grouped into three based on their ability level. Two students were selected from each group to be interviewed. Meanwhile, documentation is to record all activities at each stage. The data analysis was carried out descriptively qualitatively, in the form of a theory of induction and data reduction.

3. RESULTS AND DISCUSSION

Collecting research data in the early stages through adversity quotient scale questionnaires and tests on students' mathematical creative thinking skills. The results of the Adversity Quotient scale questionnaire from 23 students obtained the following data: 6 students (26%) quitter type, 14 students (61%) camper type, and 3 students (13%) climber type.

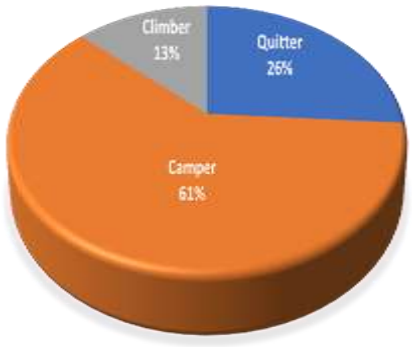


Figure 1. Classification of Adversity Quotients Categories

In this study, the test given to students was in the form of 4 limited-material questions. According to the test results, students are grouped into three based on their abilities: students with high, medium, and low abilities. There were 8 students (35%) with high abilities, 11 students (48%) with moderate abilities, and 4 students (17%) with low abilities. Two students were selected from each group to be interviewed by paying attention to student answers based on three creativity criteria; fluency, flexibility, and originality. The students with high abilities were IM (S-1) and AK (S-2), the students with moderate abilities were AG (S-3) and LN (S-4), and the students with low abilities were BM (S-5) and DR (S-6).

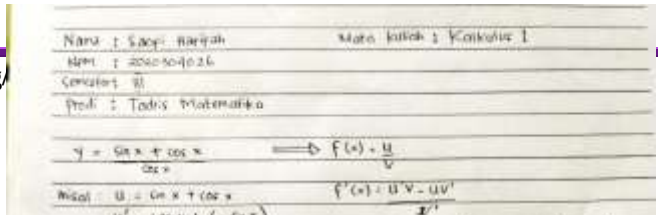
Table 1. Subject's Ability

Code	Subject	Scor	Group
S-1	IM	90	Tall
S-2	AK	80	Tall
S-3	AG	70	Currently
S-4	LN	70	Currently
S-5	BM	60	Low
S-6	DR	50	Low

Meanwhile, for creative and mathematical thinking skills in problem-solving in terms of the adversity quotient, a student was selected from each group based on the following identifications.

1. Subjects of Fluency Criteria with Quitter Type

The following is the result of subject 1's answer, the criterion of fluency with the quitter type.



$$f'(x) = \frac{u'v - u\,v'}{v^2}$$

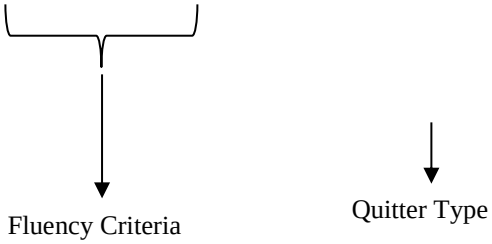


Figure 2. Subject Answer Sheet

The ability to think creatively mathematically with fluency criteria with the quitter type from subject 1 shows that in solving problem-solving, they can write concepts $f(x) = \frac{u}{v} \rightarrow f'(x) = \frac{u'v - u\,v'}{v^2}$ that are pretty long and can formulate problems, have not been able to implement simpler concepts, and is unable to verify problem-solving and the final result is wrong. The following are the results of the interview with subject 1 at the problem-solving stage:

Problem Identifying Stage

Researcher : What do you know from that question?

Subject 1 : Separation concept

$u = sinx + cosx$

$u' = cosx - sinx$

$v = cosx$

$v' = -sinx$

Researcher : What was asked?

Subject 1 : $D_x y$

The results of interviews with subject 1 show that the subject can mention what he knows from the problem with the concept of sorting that takes a long time, then the subject can mention the element being asked.

Problem Formulation Stage

Researcher : What formula or solution is used for Problem Solving?

Subject 1 : $f(x) = \frac{u}{v}$

From the interview results, the subject can determine the solution according to his knowledge.

Strategy Implementing Stage

Researcher : How is the process?

Subject 1 :

$y = \frac{sinx+cosx}{cosx}$

$= (cosx - sinx)cosx - (sinx + cosx)(-sinx)/(cosx)^2$

$= x - sinx\ cosx - (-x - sinx\ \ cosx)/x$

$= x - sinx\ cosx + x - sinx\ \ cosx/x$

$y = \frac{x+x}{x}$

Based on the interview results, the subject worked according to the formula at the problem formulation stage but not according to mathematical concepts such as forgetting to close and open brackets.

Problem Solving Verification Stage

Researcher : Has it been checked?

Subject 1 : not yet

Although the subject can answer the question, he has not gone through the Problem Solving verification stage.

2. Subject Flexibility Criteria with Camper Type

The following are the results of the answers to subject 3, the flexibility criteria with the camper type.

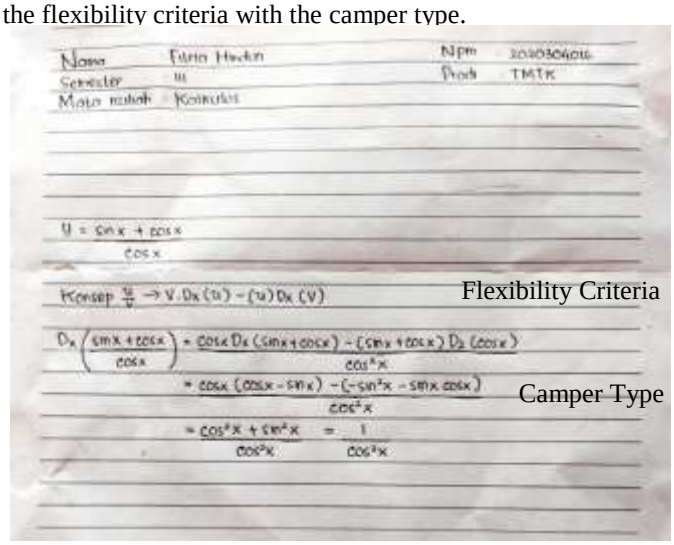


Figure 3. Subject Answer Sheet 3

$\frac{u}{v}$ with formula v. $D_x(u) - (u)D_x(v)$, the ability to think creatively on the flexibility criteria with Camper type from subject 3, shows that in solving problem-solving, they can describe more flexible concepts correctly and completely, namely mentioning concepts, able to implement the strategy according to the concept, and verify. However, the steps were not correct, so the final result was invalid. Following are the interview results of subject 3 at the problem-solving stage:

Problem Identifying Stage

Researcher : What do you know from that question?
Subject 3 : $D_x\left(\frac{sinx + cosx}{cosx}\right) \rightarrow D_x(u) - (u)D_x(v)$
Researcher : What was asked?
Subject 3 : $D_x$look for

The results of interviews with the subjects showed that the subject can mention what the concept was and explain the questions asked correctly, then the subject could mention the elements that were asked correctly and appropriately.

Problem Formulation Stage

Researcher : What concept is used for Problem Solving?
Subject 3 : $\frac{u}{v}$ $with\ formula\ v.D_x(u) - (u)D_x(v)$concepts

From the interview results, the subject can determine the concept solution and prove it with his knowledge.

Strategy Implementing Stage

Researcher : How is the process?
Subject 3:
$\boldsymbol{D_x\left(\frac{sinx+cosx}{cosx}\right)}$
$= \boldsymbol{cosx\ D_x(sinx + cosx) - (sinx + cosx)D_x(cosx)/x}$
$= \boldsymbol{cosx(cosx - sinx) - (-x - sinx\ cosx)/x}$
$= \frac{x+x}{x}$
$= \frac{1}{x}$

The subject could work with a more flexible concept based on the interview results.

Problem Solving Verification Stage

Researcher : Has it been checked?
Subject 3 : Yes

Subjects verify problem-solving and can work according to the concept at the problem formulation stage, but the verification step lacks detail, so the final result was incorrect.

3. Subject Criteria for Originality with Climber Type

The following is the result of subject 5's answer, the criteria for originality with the climber type.

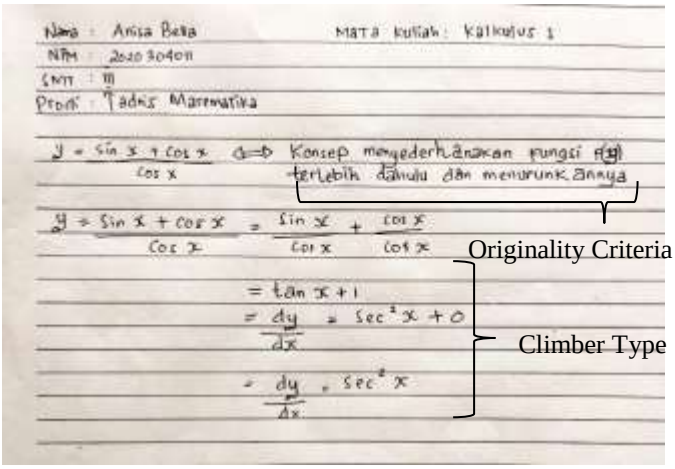


Figure 4. Subject Answer Sheet 5

The ability to think creatively mathematically, the criteria for originality, with the climber type from subject 5, showed that in solving problem-solving, one could write down a new concept (originality) correctly and precisely, namely simplifying the f( ) function first and lowering it with this concept. Furthermore, they could verify problem-solving clearly and correctly so that the final result was correct. Following are the interview results of subject 5 at the problem-solving stage:

Problem Identifying Stage

Researcher : What do you know from this question?
Subject 5 : $y = \frac{sinx+cosx}{cosx}$
Researcher : what was asked?
Subject 5 : $D_x$look for

The interview results showed that the subject can mention what is known from the question and is correct, and can explain the question asked correctly, then the subject can mention the element that is asked correctly and precisely.

Problem Formulation Stage

Researcher : What concept is used for Problem Solving?
Subject 5 : Simplify the function f(y) first, then derive it using trigonometric rules

Based on the interview results, the subject can determine and prove a new concept with his knowledge.

Strategy Implementing Stage

Researcher : How is the process?
Subjekct 5 :

$$y = \frac{sinx+cosx}{cosx}$$
$$= \frac{sinx}{cosx} + \frac{cosx}{cosx}$$
$$= tanx + 1$$
$$= \frac{dy}{dx} = x + 0$$
$$y = \frac{dy}{dx} = x$$

Based on the interview results, the subject can work with the new concept under the problem formulation and trigonometric rules.

Problem Solving Verification Stage

Researcher	**:**	Has it been checked?
Subject 5	**:**	Yes

Subjects verify problem-solving and can work according to the formula at the problem formulation stage and carry out verification steps in detail so that the final result is correct.

4. CONCLUSION

This study inferred that the fluency criteria students with the quitter type fulfill three problem-solving indicators: understanding the problem, formulating strategies, and implementing strategies. Flexibility criteria students with the camper type fulfill all problem-solving indicators, namely understanding problems, formulating strategies, and implementing strategies, but lacks detail in verifying solutions so that the final results are still wrong. Finally, the students with the originality criterion in the climber type can fulfill all the problem-solving indicators; understanding the problem, formulating strategies, implementing strategies, and verifying solutions in detail so that the final result is correct.

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