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Reasoning Adaptive Ability in Solving Questions Mathematics Logic Based on Learning Creativity

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Abstract: The purpose of this study was to analyze the adaptive reasoning skills by students' creativity in solving mathematical logic. This study uses a qualitative descriptive research method. The subject of the research was a 3rd grade student of IAIN Syekh Nurjati who was chosen by one of the students with high learning creativity, medium learning creativity, and low learning creativity. Use sampling techniques aimed at selecting subjects. The data collection techniques used were written tests, indirect communication techniques and interviews, while the tools in this study were adaptive reasoning tests, learning creativity questionnaires and interview guidelines. Use triangulation techniques to test the validity of the data. Data analysis was carried out through data simplification, data presentation and conclusion drawing. The results showed that students with high learning creativity met four indicators, namely, guessing, giving reasons for the truth of the statement, drawing conclusions from the statement, and testing the validity of the argument but did not meet the indicators of getting a model from mathematical symptoms, students with moderate learning creativity only met two indicators, namely submitting allegations and verifying the validity of arguments; students with low learning creativity only meet one indicator, namely providing reasons or evidence for statements.

Keywords: Adaptive reasoning ability; learning creativity; Math logic.

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INTRODUCTION

Logic is the science of correct thinking and reasoning. Linguistically, logic comes from the word "logos" (Greek), which means word, speech, and thought. Then this understanding develops into science. Logic belongs to the original class of mathematics, because mathematics is systematic logic. Mathematics is a logical method that uses mathematical symbols (symbolic logic). In everyday life, we often face situations that require us to make decisions. In order for our decisions to be right and correct, we must first be able to draw conclusions from the environment we face, and to be able to draw the right conclusions, we need good reasoning skills. Reasoning ability is the ability to draw appropriate conclusions based on existing evidence and certain rules.

The National Council of Teachers of Mathematics stated that one of the standards of mathematical ability needed is reasoning. In addition, (Bernard, 2015) argues that students who study mathematics need reasoning to stimulate their problem solving ideas or ideas so that students can understand the correct mathematical concepts. In addition, (Rosnawati, 2013) suggests that the conditions that must be met to master mathematics are mathematical reasoning abilities. Mathematical reasoning ability

refers to students' ability to analyze and explain problems based on concepts, and test the truth based on the causality of the information provided, and draw conclusions through formal steps (Hendiman, 2017;. In addition, reasoning is a logical way of thinking for students in inductive, namely learning to provide logical evidence to draw conclusions, and deductive learning, namely problem solving concepts based on proven knowledge mastery, allowing students to take logic-based actions on existing facts so that they can finally draw conclusions..

Adaptive reasoning includes the ability of adaptive induction and deduction. Adaptive reasoning is the ability to think logically, reflectively, explain, and prove the relationship between concepts and situations. (Widjajanti, 2011) suggests that adaptive reasoning is based on five indicators, namely 1) formulating conjectures, 2) providing reasons or evidence of the truth of the statement, 3) drawing conclusions from statements, 4) checking the validity of statements from an argument, and 5) Looking for patterns. in mathematical phenomena.

Bates & Clark (2019) shows that one of the factors that may cause students' adaptive reasoning abilities that have not been explored is the availability of measurement tools that are compatible and consistent with learning outcomes goals. Shin & Lee (2019) emphasize that the success of the learning process as a whole requires the support of learning tools, including assessment tools, as technical guidance so that the implementation of learning can run according to the goals that have been set. Shaughnessy et al. (2009) suggested that the ideal assessment tool for adaptive reasoning ability is being able to (1) make and research mathematical conjectures, (2) develop and evaluate mathematical arguments, (3) select and use various types of reasoning. In addition, the points for evaluating adaptive mathematical reasoning abilities were expanded according to research needs, namely the concept of limits (Oktaviyanthi, 2019).

Utami Munandar in Ali and Asrori (2014: 41) defines creativity as an ability that reflects fluency, flexibility, and originality in thinking and the ability to elaborate an idea. Furthermore, Utami Munandar (2014 stated that creativity as a whole personality is the result of interaction with the environment. The development of creativity can be supported by the environment where individuals interact, but there are also factors that can inhibit the development of individual creativity. Creativity that exists in individuals is used in face various problems when interacting with their environment and find other alternatives so that strong self-adjustment can be achieved.Learning outcomes can be interpreted as the level of student success in studying subjects at school, which is outlined in the scores obtained from the results of understanding tests of certain subjects .

According to Krulik (Siswono, 2005: 2), in the process of understanding and planning necessary to solve the problem of adequate ability to think creatively, because this capability is the ability to think advanced follow kemampua n basic thinking and critical thinking. Based on the views of the above, it can be concluded that in the learning process needed a method to encourage students to understand the problem, improve the ability to think creative in formulating solutions, and enables students to actively find themselves solving problems

based on exposure communicated earlier, the study aims to analyze students' adaptive reasoning abilities in solving mathematical logic problems based on learning creativity.

RELATED WORK

Reasoning as a way of thinking, which connects two or more things according to certain attributes and rules, and these attributes and rules draw conclusions through the use of proof steps. Keraf (1999:16) argues that reasoning is a thought process that tries to relate known facts to conclusions. Both definitions show that reasoning is a person's way of thinking to draw conclusions based on known facts and traits or previously proven rules. The National Research Council (in Killpatrik., et al, 2001:129) introduces a type of reasoning, its research includes inductive and deductive abilities, then introduces the term adaptive reasoning. Adaptive reasoning refers to the ability to think logically

about the relationship between concepts and situations, the ability to think reflectively, the ability to explain and the ability to justify.

Students can demonstrate adaptive reasoning abilities when faced with three conditions, namely: (1) having adequate basic knowledge, (2) easy-to-understand assignments and can motivate students; (3) which presented a familiar and fun context for students. Thus, learning mathematics is always related to cognitive preparation. Adaptive reasoning is inseparable from other abilities in learning mathematics, including problem solving skills.

Logic is the science of correct thinking and reasoning. Thus, the reasoning process of this course must be improved. According to Bernard (2015: 197-222), students need to use reasoning to stimulate their ideas or solve problems when learning mathematics, so that students can understand students' mathematical concepts. Reasoning ability is one of the most important skills needed to study mathematics today and in the future. In mathematics, students must be able to understand inductive, deductive, and intuitive reasoning. These three reasons are included in adaptive reasoning.

Adaptive reasoning requires students to make logical thinking that makes sense based on known facts, and correctly uses their own reasoning to solve problems, and really pays attention to whether the procedures completed are in accordance with applicable rules. In addition, Reid (2018:1-13) suggests that adaptive reasoning itself is the ability to think logically about the relationship between concepts and programs that are generalized in a meaningful way, making it possible to solve problems and in a reasonable way.

Improving creative thinking skills means increasing students' ability to understand problems, smooth problem solving, flexibility and novelty". If students can point to known and asked questions, they state that they understand the problem; if they can solve problems with various logically correct answers, the student is fluent in problem solving; if they can solve two or more problems, students have flexibility in solving problems using more different and correct methods. If students can make answers that are different from previous answers or answers that are commonly known to students, then they will have new ideas in solving problems.

Several studies on adaptive reasoning abilities include: 1) (Indriani et al., 2017) suggesting that students' adaptive reasoning abilities are still very low; 2) (Afifian & Setyaningsih, 2019) stated that students have not been able to fully master the indicators of this adaptive reasoning ability. Research shows that adaptive reasoning is still low.

This also happened to students, during pre-observation, 37.04% of students were able to solve adaptive reasoning problems, so they were in the low category (Oktaviana & Haryadi, 2020). In addition, through observing student problem solving, it was found that students were still less creative in answering the questions in the answers, and problem solving was still based on concepts, so that students would encounter difficulties when facing new problems. Thus, the ability of students is also influenced by the factor of learning creativity.

METHODS

In conducting research on how big the level of students' adaptive reasoning in solving or answering questions about mathematical logic, this time the method used is descriptive qualitative research method, which means that this research method uses qualitative data then described, this aims to produce a clear and detailed picture of students' adaptive reasoning abilities. Class C students in semester 3 who are taking courses in Mathematical Logic and Sets (LMH) are used as subjects in the study, by selecting students according to the learning creativity possessed by students, namely high, medium, and low. Located in the Department of Mathematics Education IAIN Sheikh Nurjati. Research with qualitative descriptive method is carried out in natural conditions (naturalistic), using purposive sampling technique in which the data is taken by the steps taken.

The first step is to give a learning creativity questionnaire to students, this questionnaire is in the form of a written test that is used to obtain information from respondents about their personality or things they want to know, but in this study the data that you want to get is how students' adaptive reasoning in dealing with questions. -mathematical logic questions.

The second step is to carry out data analysis related to the questionnaire in determining the research subject. The data analysis in this study is related to 1). Data reduction related to all processes of selection, focusing, simplifying, and abstracting (rough) data obtained in the field. 2). Presentation of data, relating to activities to describe or describe an organized collection of information so that it is possible to draw conclusions and provide a clear picture of research results. 3). Drawing conclusions, namely drawing conclusions about the types of errors that are often made by students when working on souls and the factors that cause them.

The third step is to give tests to the subject or research actor, which is related to the Adaptive Reasoning Test, this is used to obtain qualitative data regarding students' adaptive reasoning in solving problems mathematics, especially regarding the material of logic.

The last step is to conduct interviews with research subjects. Interviews are a process that aims to obtain information and then serve as the objectives of the research by means of question and answer while face to face between the interviewer and the respondent or the person being interviewed, using or not using the interview guide.

However, it is necessary to test the validity of the data obtained by the technique with the technique that must be taken, namely the triangulation technique. Triangulation in the credibility test has the purpose of checking data from various sources in various ways and times. Where triangulation is used as a tool to test the credibility of a data that relies on various sources. How to find out adaptive reasoning on each selected student by asking them to work on the same problem. Data from the tested subjects were then described, grouped according to each subject's view.

The procedures or stages in this research, namely there are several stages, namely: The first stage is preparation, including preparation of research instruments such as making or compiling question grids, compiling test questions used to measure adaptive reasoning abilities, making alternative answer keys, Scoring guidelines or rubrics, and interview guidelines then Conduct content validity tests on research instruments by experts, Revise instruments based on validation results, Test questions, Analyze data obtained from test test results, Revise research instruments based on test test results, Duplicate or reproduce questions and Manage research permits at schools that are intended or as research subjects.

The second stage is the implementation of research activities related to providing adaptive reasoning ability tests to students, analyzing or correcting students' answers in each number of questions given, grouping the answers given by students based on incorrect answers to each question number and each group of answers taken by 1 student. randomly assigned to be interviewed, conducting interviews with research subjects to complete the process of solving adaptive reasoning test questions that were not revealed through written answers and data collection that had been obtained.

Then the third stage is the Data Analysis and Activity Reporting Stage. Data analysis is an effort taken by working with data. However, in this context, the data sought is related to the implementation or analysis of quantitative data on the results of the student's adaptive reasoning ability test, to describe the results of the adaptive reasoning ability test. adaptive reasoning abilities, Conducting discussions based on quantitative and qualitative data analysis and Making conclusions as answers to problems in research and suggestions.

RESULT AND DISCUSSION

Based on the Academic Creativity Questionnaire, the researcher selected 2 students from 28 students who responded to the Academic Creativity Questionnaire as research subjects. For 2 students whose data will be analyzed in an adaptive reasoning test and an interview will be conducted, 1 person is selected in each category of academic creativity.

Table 1: Students who are selected as research subjects can be consulted

No	Code	Value of	creativity
1	ASS (S1)	87	High
2	CTL (S2)	50	Low

In addition, they will carry out descriptions and data analysis based on students' adaptive reasoning abilities to solve mathematical logic questions. Below are test questions for adaptive reasoning skills in the questions below.

1. It is known that the form of a compound statement (~p^q) ~r , then determine the negation of the compound statement and show the truth value of the compound statement and its negation formed

2. Given a compound statement (p^~q) ~ ~(p^q). Check whether the following statement is a tautology of contradiction, or contingency! Why?

3. Use de Morgan's theorem to determine the equivalent of ~ ((~p^~q)v~) and show using a truth table whether it is equivalent!

4. it is known that the following conclusions are drawn:

P q (Premise 1)

~qvr (Premise 2)

~r (Premise 3)

Determine the correlation and show it with a truth table

5. Show that the following argument:

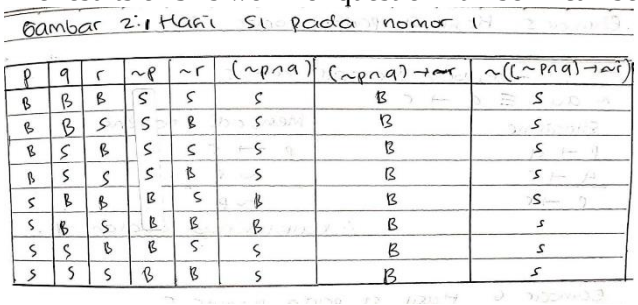
"If the sea water recedes after an earthquake at sea, then a tsunami came, the sea water receded after the earthquake in the sea, therefore the tsunami came"

Is this argument valid? Give a detailed explanation!

Of the questions given contain five indicators of adaptive reasoning where question number 1 contains a list of finding patterns in mathematical phenomena, number 2 contains statements about conjectures, question number 3 contains all indicators that prove the truth of a statement, there is not a single statement that is interesting from a statement. , and question number 5 contains an indicator of the validity of an argument. The following is a description of the reasoning ability in solving mathematical logic problems.

Description of Written Test Results for S1

The results of S1's work for question number 1 can be seen in Figure 1.



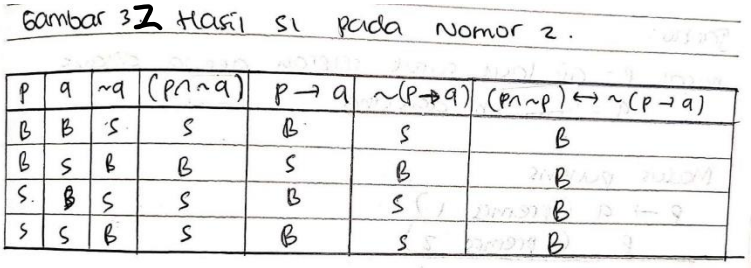
Gambar 2. Hasil S1 pada nomor 1

p	q	r	~p	~r	(~p∧q)	(~p∧q)→r	~((~p∧q)→r)
B	B	B	S	S	S	B	S
B	B	S	S	B	S	B	S
B	S	B	S	S	S	B	S
B	S	S	S	B	S	B	S
S	B	B	B	S	B	B	S
S	B	S	B	B	B	B	S
S	S	B	B	S	S	B	S
S	S	S	B	B	S	B	S

Figure 1. Results of S1 on number 1

Based on Figure 2 it can be seen that he could not find the pattern of the questions given. S1 only determines the negation of the given compound utterance by only adding the negation symbol (~) of the given compound utterance while the pattern or negation concerned must use the negation of P q of the given compound utterance. So far, based on interviews with the subject of S1, it was found that S1 forgot what the negative results were, so he did not explain the results. Therefore, it can be concluded that S1 does not respond to indicators of finding patterns in mathematical symptoms.

The results of S1's work for question number 2 can be seen in Figure 2.



Gambar 3.2 Hasil S1 pada Nomor 2.

p	q	~q	(p∧~q)	p→q	~(p→q)	(p∧~p)↔~(p→q)
B	B	S	S	B	S	B
B	S	B	B	S	B	B
S	B	S	S	B	S	B
S	S	B	S	B	S	B

Figure 2. Results of S1 in number 2

Based on Figure 2, it can be seen that S1 can make conjectures to determine compound statements, including determining the type of statements that S1 tabulates the truth of compound statements. The truth table is arranged correctly and precisely so that in determining compound speech, S1 can also determine the type of calculation correctly and precisely. In addition, S1 also provides the right and correct reasons why the statement is included in the calculation.

Based on the interviews conducted, information was obtained that S1 really understands factual tabulations and can be interpreted accurately when asked. Therefore, it can be concluded that S1 has reached the Composite Statement Hypothesis Index.

The results of S1 for question number 3 can be seen in Figure . In the picture, it can be seen that undergraduate students understand the concepts used to solve the given problem. It can be seen that S1 first determines the equivalent statement of the compound statement given by the concept of de Morgan's Theorem, then S1 provides a proof of the truth of the given statement by making a truth table of two statements per sentence. side, left and right. The next step is S1 compares the results of the left and right sides of the truth table and concludes that the two statements are equivalent.

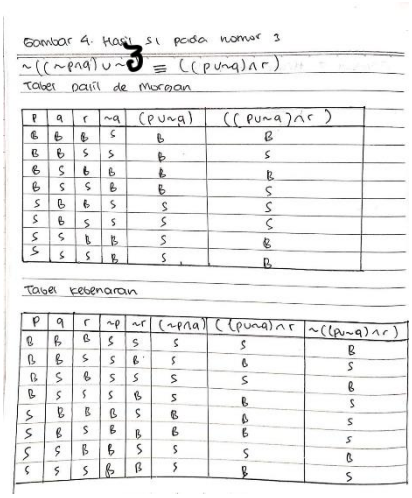


Figure 3. Results of S1 in number 3 From the interviews conducted,

S1 can describe how to answer questions and can mention the equivalent statement correctly and correctly. Based on this, it is said that S1 has met the requirements to find out the reason for the statement.

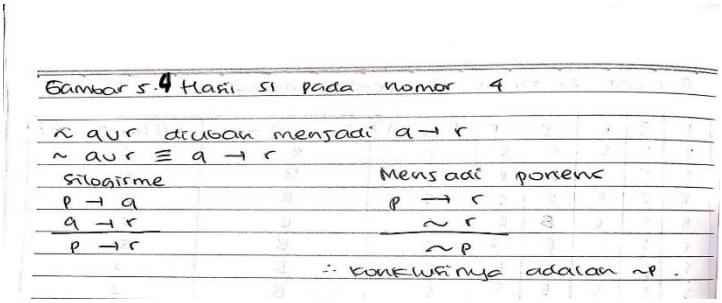


Figure 4 . Results of S1 in number 4

In Figure 4 it can be seen that S1 students understand the concept of withdrawal where S1 can draw conclusions from the premises given. It can be seen that S1 is able to determine the conclusion correctly and precisely where S1 first determines the conclusion from the two premises at the beginning and can change it really or equivalently so that at the time of determining He also actually draws conclusions from the two conclusions.

then the results obtained with the third premise and S1 can also determine conclusions based on the concepts drawn.

Interview with S1 it was found that S1 gave the correct explanation by answering questions where S1 was familiar with the concept of conclusion about the syllogism by modifying one of the premises to fit the concept of syllogism. Thus, S1 finds clues to draw conclusions from a statement.

The results of S1's work for question number 5 can be seen in Figure 5

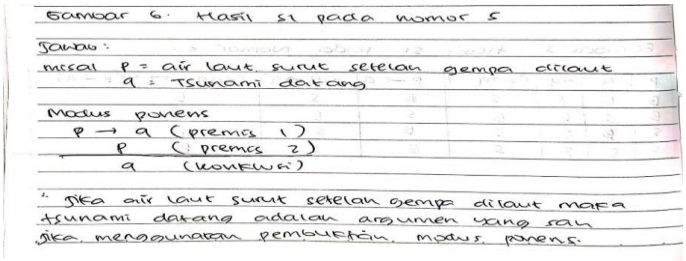


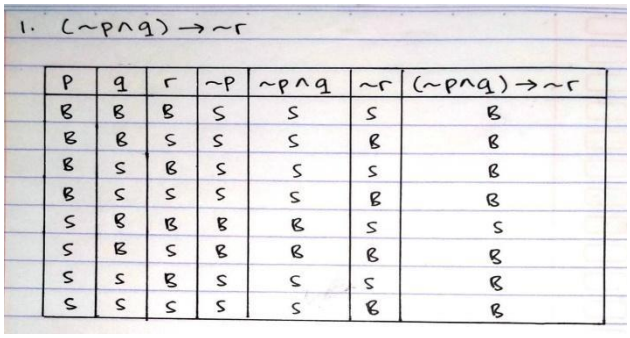
Figure 5: Result on number

The results of S1 on number 5 In Figure 5 it can be seen that S1 students can check the validity of the questions by forming arguments in logistic statement notation and then S1 can determine that numbers are included in the ponens mode where S1 gives answers true and true. It can be seen that S1 understands the concept of withdrawal where when determining whether or not the argument is valid, S1 says it is included in the modus ponens.

Interview Based on what was done with S1, it was found that S1 understood the meaning of the modus ponens inference even when asked about the meaning of all conclusions and that S1 explained it correctly, precisely and precisely. Thus, S1 satisfies the index of checking the validity of an argument.

Description of Written Test Results at S2

The results of S2's work for question number 1 are shown in Figure 6.



1. $(\sim p \wedge q) \rightarrow \sim r$

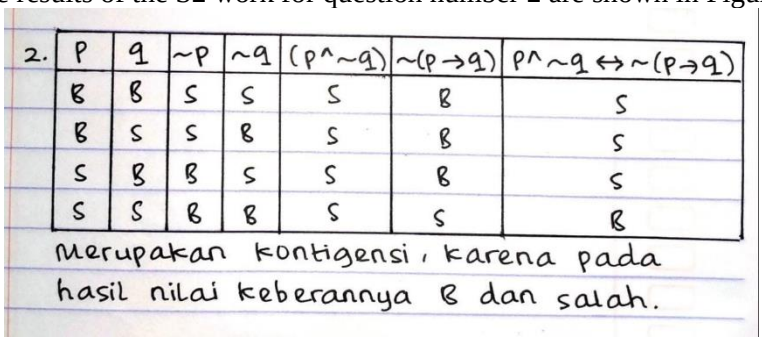
p	q	r	~p	~p ^ q	~r	(~p ^ q) → ~r
B	B	B	S	S	S	B
B	B	S	S	S	B	B
B	S	B	S	S	S	B
B	S	S	S	S	B	B
S	B	B	B	B	S	S
S	B	S	B	B	B	B
S	S	B	S	S	S	B
S	S	S	S	S	B	B

Figure 6: Result test S2

The results of S2 at number 1 S2 cannot find the negation of the compound statement given in the problem. It can be seen that S2 only forms the truth table of the given statement.

Based on the interview with the subject of S2, it was found that S2 did not understand how to find the negation of a statement. Therefore, it can be said that S2 cannot find the search index for mathematical symptom patterns.

The results of the S2 work for question number 2 are shown in Figure 7.



2.

P	q	~P	~q	(P ^ ~q)	~(P → q)	P ^ ~q ↔ ~(P → q)
B	B	S	S	S	B	S
B	S	S	B	S	B	S
S	B	B	S	S	B	S
S	S	B	B	S	S	B

Merupakan kontigensi, karena pada hasil nilai keberannya B dan salah.

Figure 7: Resutl Test S2 work for question

The results of S2 in No. 2 Based on Figure 7, S2 cannot be hypothesized. It can be seen that S2 cannot tabulate the truth correctly where S2 does not create a column to determine the final result of the statement S2 does not add up the truth of P q but S2 immediately finds the truth. ~(P q) and the truth value formed by ~(P q) is also false. In addition, S2 is also wrong about the truth value of the second row, so it is not feasible from S. Since the truth values and ~(P q) generated by S2 are false, the final result of l The compound statement of the problem also contains errors. in its formation. Based on the interview, it was found that S2 could not correctly interpret the truth value of ~(P q). S2 admitted that he was wrong in determining the truth of the compound statement. Therefore, we can say that S2 cannot be applied to construct estimates.

The results of S2's work for question number 3 can be seen in Figure 8.

On question No. 3 S2 understands the concept of De Morgan's Theorem where in determining the equivalent statement to the compound statement on the problem, S2 is carried out correctly.

From the interview, S2 understands the concept of truth-seeking statements. S2 can classify when looking for answers from (Pv~q)^r. Based on this, the keyword S2 has fulfilled the requirements to find the reason for the statement.
The results of the S2 work for question No. 4 is shown in Figure 9.

The results of S2 on the number In Figure 9, S2 cannot draw conclusions from the questions given. S2 is not a conclusion from the questions asked.

Interviews with Masters obtained information that Masters did not understand the concept of drawing conclusions from 3 premises. Therefore, S2 does not respond to indicators to draw conclusions from a statement.

The results of S2's work for question number 5 are shown in Figure 10.

S2 cannot verify the validity of the arguments given. We see that S2 only forms statements or arguments that lead to problems with logistic symbols.

Based on the interview with S2, it is known that S2 is not able to reinterpret the answers given, where S2 admits that by answering, they are only guessing. Therefore, S2 cannot meet the validity check index of an argument.

Based on the results of the analysis of student work and interviews conducted, it appears that students with high creativity respond to four indicators, namely making hypotheses, providing valid reasons for a complaint, drawing conclusions from a statement, and testing the validity of arguments but not meeting the index. models of mathematical phenomena. Students with academic creativity averaged only two measures, making guesses and testing the validity of arguments. This happens because students with creative abilities do not master the concept of the negation of a statement, while the valid statement of a statement and finds patterns that contain questions that find the negation of a statement. In addition, the average creative student does not understand how to draw conclusions with 3 premises that make conclusions impossible.

Students with low creativity only respond to one indicator, namely confirming or confirming a statement. Students who are not creative do not master the concepts of mathematical logic, making it difficult to understand due to the lack of information provided (Hanifah, 2016; Hidayah, 2016; Irawati, 2015). This shows that creativity is related to students' reasoning, where students with high creativity can complete more indicators than those with average, medium and low creative abilities. In addition, students who are very creative can connect knowledge with new things they find. In addition, research (Amalia, 2015; Purnamasari, WA & Hadiyah, 2013) also supports that students with academic creativity have better understanding and learning outcomes than students with high academic creativity.

CONCLUSION

Based on the results and learning, that students with high creativity are qualified to make assumptions, provide valid reasons for a statement, and prove arguments, but fail to take notes. indicators by looking for mathematical diagrams of these symptoms. Academic creativity was met with indicators that made hypotheses and tested the validity of arguments, and students with low creativity only encountered indicators that provided evidence or evidence above conjecture. And we suggest that students practice more independently with questions, especially things related to inference. Before answering questions, students must first master or understand mathematical logic concepts so that

students' reasoning abilities can be carried out correctly and accurately. In addition, other research may apply learning models that focus on improving adaptive reasoning.

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