

Analysis of Students' Reasoning Ability in Solving Non-Routine Math Problems in terms of Learning Style

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Abstract

The purpose of this study is to describe students' mathematical reasoning abilities in solving non-routine problems in terms of learning styles. The type of research used is descriptive with qualitative data. The research subjects were students of class XI IPA. The instruments used are questionnaires, non-routine test questions, and interviews. The data to be taken are data on questionnaires, test questions, and interviews. The data obtained will then be analyzed in a descriptive-qualitative way. The results of this study are that 11th-grade students of MA Muhammadiyah 1 Plus Malang, have several learning styles, namely: visual, kinesthetic, and auditory, respectively: 67%, 25%, and 8%. Students with visual learning styles have fairly high reasoning abilities by meeting indicators such as 1) being able to present and make mathematical statements in writing well 2) being able to manipulate y-values, and 3) compiling solutions to existing problems. While students with kinesthetic learning styles, students meet reasoning ability indicators, including 1) writing mathematical statements well, and 2) manipulating target functions, then students with auditory learning styles only have one indicator of reasoning ability, namely: 1) creating and finding solutions to trouble well.

Keywords: mathematical reasoning; non-routine questions; learning style

INTRODUCTION

One of the subjects in school that is taught, starting from elementary to high-level education, is mathematics (Funds, 2019). On the other hand, in the mathematics learning process, students must have, one of them is reasoning ability (Jami and Wijayanti, 2020) where reasoning ability is defined as the ability to improve abilities ranging from proof, giving ideas, and solving problems to drawing conclusions (Puspita et al., 2020). This reasoning ability can be said to be the basis of thinking that students must have in learning mathematics. Another opinion says that the ability to learn mathematics is defined as an activity or process of thinking in solving everyday problems (Ramdani, 2019).

This research was taken because, in a mathematics lesson, mathematics and reasoning are two things that cannot be separated because understanding mathematics requires reasoning, so that reasoning must be owned by every student in learning mathematics (Hermawan & Winarti, 2015; Astuti & Abadi, 2015) in (Sahija, 2020) and this is also supported by research Suprihatin, Maya, & Senjayawati (2018) which says if the reasoning is used to solve problems in mathematics because according to the purpose of studying mathematics is to

improve one's reasoning. Given the importance of reasoning skills in learning mathematics, all parties must try to develop and train students' reasoning, especially teachers.

The teacher is used as a transmitter of information to students, and the teacher's methods in learning can affect student learning outcomes later. One of the tendencies of teachers in learning to use delivery of learning based on the teacher's own learning style (Widayah, 2016). Where the learning style here is defined as the tendency of students' ability to absorb and communicate information effectively and can be seen in the way of learning, speaking, doing assignments to discussion activities. (Darkasyi, 2014; Mar'ah, 2015)). Another opinion says that learning style is not an ability but rather the way a person uses his abilities (Sugiyanto, 2014).

In Indonesia, the best known learning style approach is learning based on sensory preferences which is divided into 3, namely 1) visual style, namely by sight, 2) auditory style, namely by hearing and 3) kinesthetic style, namely by direct movement or activity. (Zubaidah, 2016). Student learning styles are needed in seeing how students solve non-routine questions (Erdogan, 2015).

Non-routine questions themselves are defined as questions whose solutions require broader and unusual thinking because the procedures are not as clear as the procedures taught in class. (Sizilia, 2018). Another opinion says that non-routine questions are defined as questions that are not usually taught in classroom learning which will usually focus more on a high level of interpretation and problem organization. (Aisyah, 2010). On the other hand, non-routine questions can also be interpreted as questions that relate topics to one another, not just a good memory challenge. (Gordah, 2012).

Based on the experience of researchers in internships 2 and 3, there are still teachers who use the lecture method in their learning so that it makes students bored and the information provided does not reach students because of differences in learning styles which result in students' reasoning abilities are still being questioned.

The use of non-routine questions is because, as we all know, routine questions are specially designed questions whose work is not structured as usual and has a higher level. (Sizilia, 2018). So from the definition of non-routine questions, the selection of non-routine questions because the questions are specially designed and higher than routine questions (usually) will develop the level of reasoning ability compared to ordinary (routine) questions. This is supported by the statement Rita, Zulkardi, & Hartono (2015) who said that giving reasoning questions that were specially designed, unusual, unstructured (non-routine) would indirectly be able to develop children's reasoning abilities higher than the questions they used to do.

Judging from previous research conducted by Fund (2019) shows that there are differences in the level of reasoning ability in each person's learning style, for example students with auditory and kinesthetic learning styles are higher than people with visual learning styles whose reasoning abilities are. While other research was conducted by Puspita et al (2020) resulting in differences in student learning styles to make reasoning abilities in terms of student learning outcomes. Thus, the differences between students in managing information cause differences in students' mathematical abilities (Sri, 2018). Two previous studies used routine

questions in class, while in this study, researchers wanted to know students' reasoning abilities through non-routine questions which required further thinking and the steps were rarely taught in class, of course, it was reviewed based on the students' learning styles.

Based on some of these descriptions, researchers are interested in conducting research with the title "Analysis of Students' Reasoning Ability in Solving Non-routine Mathematics Problems in terms of Learning Style". The purpose of this study is to describe students' reasoning abilities in terms of learning styles in completing non-routine mathematics.

RESEARCH METHOD

This study is a study that aims to describe students' reasoning abilities in terms of learning styles in solving non-routine math problems. Therefore, the research approach used in this study is a qualitative approach with a descriptive type of research. This research will be carried out in class XI IPA MA Muhammadiyah Malang totaling 19 people. The researcher chose MA Muhammadiyah Malang, because the researcher had had an internship at the school so that the researcher knew the field conditions and the students in solving routine questions. The object of this research is the students' reasoning ability in solving non-routine questions in terms of learning styles. In this study, the researchers divided the research stages into three stages, namely:

- a) **Planning stage**
The first activity carried out during the planning stage is an application for a research permit to the principal of the school concerned. Conduct preliminary observations and coordination of mathematics subject teachers for class XI. Before the research is carried out, it is necessary to prepare learning tools in accordance with the research that will be carried out later, including non-routine questions. Develop research instruments, learning style questionnaire guidelines, and research administration files to support the smooth running of the research.
- b) **Stages of implementation**
In this stage, the researcher conducts or goes directly to the field to get the data needed. This research was conducted by the researcher himself and also an observer who assisted in carrying out and documenting research activities. The procedure carried out in this study is to explain the implementation of the tar to the teacher, then explain it to the students. on. Then explain the test procedure to students. During learning, the researcher gave a questionnaire to the students regarding their mathematical reasoning ability on learning styles. At the end of the meeting students were given non-routine questions to determine students' reasoning abilities in solving problems and the researchers conducted an analysis of student work.
- c) **Reporting Stage**
The final stage in this research is the reporting stage which includes the data processing stage, analyzing research data, presenting and making conclusions

on the research that has been carried out. The results of the research that have been neatly arranged will be discussed with the supervisor as a result of the research that has been carried out.

In the process of collecting data, researchers directly collect data on the object of research in order to obtain valid data, the researchers must do the following things:

a) Questionnaire

The learning style questionnaire used by researchers to determine the learning styles of class XI MA Muhammadiyah Malang students used a Jonelle A Batrice questionnaire that was sourced from a book he wrote entitled Learning to Study Through Critical Thinking. The questionnaire was translated by the Center for Development of Syarif Hidayatullah State Islamic University (UIN) Monday, 7 May 2018. This learning style questionnaire was given to class XI students before learning or before the implementation of non-routine test questions.

b) Non-routine test questions

In this research, a non-routine test will be carried out. After students fill out the learning questionnaire, the researcher will classify them into three learning styles, namely visual, kinesthetic and auditory learning styles. Furthermore, the researchers gave non-routine test questions to several students who had been selected based on each category of learning styles.

Where tests (non-routine questions) will be given to students who are selected by researchers to be research subjects to determine the level of students' reasoning. This test is given in details of description questions. The data obtained in the form of answer sheets from students.

c) Interview

This interview was conducted when students finished completing non-routine questions and the students interviewed were students selected by researchers who were included in the classification of categories for each learning style. This is done with the aim of finding out more about students' reasoning abilities in participating in learning. So that later the interview results that have been obtained can be used to examine the data in working on non-routine questions that match the answers to the research subject's test.

In this study using measuring instruments or instruments in this study were used to collect data needed in compiling research results. The instruments used are:

a) Learning Style Questionnaire

The instrument for classifying learning styles in this study was in the form of a questionnaire. This questionnaire aims to obtain data on student learning styles. Learning style classification questionnaires will be given to students at the beginning of learning. This questionnaire consists of 13 statements. Each question item consists of three answer choices. The three answers represent the characteristics of each learning style. The student's task is to choose one of the three answer options available for each statement item. The researcher has attached the list of questionnaires.

The criteria for grouping students in learning styles are as follows:

- (1) If the visual learning style score (V) is the highest score ($V > A$ and $V > K$) then the student is classified as a visual learning style type

- (2) If the auditory learning style score (A) is the highest score ($A > V$ and $A > K$) then the student belongs to the auditory learning style type.
 - (3) If the kinesthetic learning style score (K) is the highest score ($K > A$ and $K > V$) then the student is classified as a kinesthetic learning style type. (Anintya et al, 2017).
- b) Non-routine Questions Test Sheet
- The test instrument in working on non-routine questions. This test is used to see students' reasoning abilities based on reasoning indicators which consist of
- 1) presenting mathematical statements either in writing, diagrams or pictures,
 - 2) performing mathematical manipulations,
 - 3) compiling and providing reasons for the correctness of the solution, and
 - 4) drawing conclusions from logical statements. .
- The test questions consist of 4 items with different score proportions for each answer. For non-routine questions the researcher attaches to the end of this proposal.
- First, the researcher makes questions based on indicators of basic competence and reasoning abilities, which will later be validated to expert lecturers and mathematics teachers until they are declared valid to be used in this study.
- c) Interview
- This interview was conducted in a structured manner in the interview guide to determine the students' reasoning abilities with the aim that the subjects could express their opinions and ideas/answers that they had written down.

RESULTS AND DISCUSSION

1. Learning Style Results

In this study, to identify each student's learning style, the researcher gave a questionnaire to be filled out by the students. This questionnaire was filled out on Thursday, September 16, 2021, which was attended by 24 students of class XI MA Muhammadiyah 1 Plus Malang. Based on the results of the student learning style questionnaire distributed by the researchers, the results are as follows:

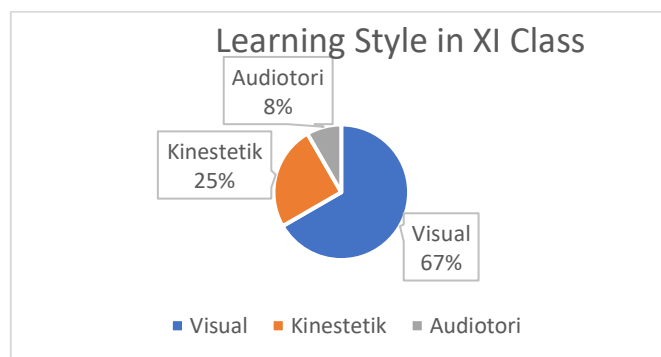


Figure 1. Percentage of Student Learning Styles

Based on Figure 1. It can be seen that the class IX students are dominated by students with visual learning styles with the percentage reaching 67%, then the kinesthetic learning style is equal to and the last is the auditory learning style is

25% . Based on these results, the researchers also chose research subjects as in table 2 below:

No	Learning Style	Code	
		Student	Learning Style
1	Visual	S1	V1
		S2	V2
2	Kinesthetic	S3	K1
		S4	K2
3	Auditory	S5	A1
		S6	A2

The selection of research subjects was carried out by considering the number of students who had different learning styles in each learning style, so the researchers chose 2 students for each type of learning style, namely undergraduate and graduate students with visual learning styles, doctoral students and doctoral students. with Kinesthetic learning style and S5 and S6 students with auditory learning style.

2. Students' Reasoning Ability



Figure 2. Researchers Distribute Questions

The Figure 2 shows that the researcher collaborates with the mathematics teacher to distribute questions to students who are the research subjects, because it is still in limited face-to-face learning, the mathematics teacher enters and assists in the class. The giving of this question will take place on September 19, 2021.

To determine the students' reasoning ability, the researcher used non-routine math problems with linear programming material to be done by class XI students. The results of the students' reasoning ability scores are as follows:

Table 2. Student Reasoning Ability Results

NO	Learning Style	Student	Mark
1.	Visual	S1	79
		S2	52
		S3	69
2.	Kinesthetic	S4	45
		S5	15
3.	Auditory	S6	53

Based on table 2. It shows that S1 and S2 students with visual learning styles get scores in reasoning abilities, namely 79 and 52, respectively, while for S3 and S4 students with Kinesthetic learning styles get values for reasoning abilities, namely 67 and 45, respectively. Finally, S5 and S6 students with Auditory learning styles scored 15 and 53, respectively.

3. Analysis of Students' Reasoning Ability in terms of Learning Style

There are several analyzes of students' reasoning abilities in terms of learning styles:

a. Visual Learning Style

The results of students' answers with visual learning styles, in question no. 1, student 1 answered starting to make an example and write down what was known, make an experiment to find the values of x and y correctly to write down how much profit, S1 students answered it smoothly but in the final result the asking for the maximum profit S1 students have not been able to answer correctly because the maximum profit is not worth it Rp. 280.000. While the answers of S2 students show that answering questions by formulating x and y variables, making mathematical models, making simulations to determine coordinate points, finding x and y values, which is 20. However, in determining the maximum benefit of S2 as well as S1, it is still not correct.

In question number 2, S1 students answered starting from assuming the variables in the problem, writing down information in writing until finally making a mathematical model of problem number 2 correctly. Meanwhile, student 2 directly wrote down the mathematical model of the existing problem with the correct answer directly without making an example or making a simulation.

In question number 3, S1 students write down the known problems in the problem, make simulations from the information in the problem, create objective functions and look for x and y values even though the values are not correct and this student has also not concluded how many cows and goats are there. must be purchased for maximum profit. While S2 students answered by making inequalities in the problem, then determining the values of x and y correctly, but in the case of S1 students, S2 students still could not find the correct answer to the existing problems.

In question number 4, S1 students answered by making an example of what is known in the problem, making a simulation by converting the information in

the problem into functions and mathematical models. Meanwhile, S2 students immediately answered with the answer to the mathematical model directly. These two students both S1 and S2 answered question number 4 with the correct final result.

b. Kinesthetic Learning Style

The results of students' answers with kinesthetic learning styles. In question number 1, the doctoral student answered by changing the information into several manipulations of the x and y variables, making the target function to find the x and y values, which were 20 each, the doctoral student also produced the maximum profit value, namely 280.000, but this answer is still not correct. While S4 answered number 1 starting with question number 1 by changing the information in the question into a written statement in the form of numbers and variables, this student also writes the maximum function correctly, until he finds points x and y which are each worth 20, but S4 students have not been able to find the maximum benefit requested in the question. .

In question number 2, doctoral students start by making changes and manipulating information into the form of variables and tables, so that students create a mathematical model with the correct answer. While S4 students start answering question number 2 by writing down what is known in the problem, so that they find the value and target function and mathematical model correctly, these students also determine the maximum advantage in the problem, but students do not understand what is asked in the question which only asks to make mathematical model of the problem at hand.

In question number 3, doctoral students answered by changing by manipulating the information in the question into a table of variables and target functions, students also then looked for the values of the x and y variables, which were worth 5 and 10 respectively, until finally these students found that to achieve maximum profit it is necessary to buy 5 cows and 10 buffalo. While the S4 students started answering question number 3 by converting the information in the questions into statements into tables and variables, these students also made mathematical models correctly, but had not yet found how many buffalo and cows to buy in order to get maximum profit.

In question number 4, the doctoral student answered by changing the information in the question into a table containing variables and target functions, until this student answered by making a mathematical model correctly. Meanwhile, S4 students answered question number 4 by making tables of existing problems, making target functions and mathematical models to making pictures.

c. Auditory Learning Style

The results of students' answers with an auditory style. In question number 1, S5 students immediately calculated in order to find a solution to the problem, namely the benefits obtained from written batik and stamped batik, but this student's answer was still not correct. Meanwhile, S6 students answered by directly manipulating the target function from the information in the question, students also determined the value of x and y , each of which was worth 20, until

the student calculated the maximum profit but was still wrong in completing the final result.

In question number 2, S5 students answered by making an example of the information in the problem and creating a target function and mathematical model to find the values of x and y to calculate the profit value, but these students did not seem to understand what was asked in question number 2, namely the question only asked for make a mathematical model of the existing problem. While S6 students answered question number 2 by directly making solutions to existing problems, namely making mathematical models correctly. In question number 3, S5 students did not answer the question, while S6 students answered question number 3 by making a table of information expressed in the form of variables and numbers, until they found the values of x and y , but this child had not clearly defined the values of x and y . As a what. In question number 4 also S5 students did not answer. Meanwhile, S6 students stated information in the form of tables and variables x and y , and made mathematical models of the existing problems, but these students have not mentioned or made conclusions from what they have written.

Based on the exposure of the research results, it is known that the results of the student learning style questionnaire for class XI MA Muhammadiyah 1 Plus indicate that visual learning styles dominate from other learning styles, namely 16 students have visual learning styles, while 6 students have kinesthetic learning styles and 2 students have auditory learning style or in percentage of students' learning style visual : kinesthetic : auditory successively equal to 67% : 25% : 8%. This shows that the visual learning style is the most common learning style in class XI. This result is also supported by previous research conducted by (Edimuslim et al, 2019) which states that the visual learning style is still the dominant class in the class that is equal to the 5 existing learning styles. Other research also shows that students with visual learning styles achieve the most 1 among other learning styles 40% (Sayuri and Yuhana, 2020).

Students with visual learning styles are able to present mathematical statements both in writing and in tabular form, students are also able to manipulate by making x and y points, and compiling solutions. These results are supported by the results of previous research conducted by Bachri (2020). Research conducted by Puspita et al. (2020) also shows that students with visual learning styles are able to make statements in the form of what is known and conjecture, manipulate to develop solutions to problems.

Students with kinesthetic learning style are able to express written mathematical statements in the form of tables, make manipulations of the target function in problems, but students with kinesthetic learning styles have not been able to develop detailed solutions and make conclusions through logical statements. These results are supported by previous research conducted by Fund (2019) which results that students with kinesthetic learning styles have mathematical abilities, namely being able to present mathematical statements in writing well, quite capable of performing mathematical manipulations and lacking in finding patterns and

compiling solutions to less in making conclusions from logical statements. Other research was also conducted by Afif (2019) This results in writing statements in the form known in the problem in writing and making manipulations.

Students with auditory learning styles are able to find or make solutions to existing problems, but are less able to make written statements and are unable to manipulate and draw conclusions from existing problems. These results are also supported by previous research conducted by Damayanti (2020) which states that students with auditory learning styles are considered unable to solve reasoning problems properly, because they only write solutions in problems.

Based on the description above, it is concluded that students with visual learning styles have a fairly high level of ability by meeting three indicators of reasoning ability, while students with kinesthetic learning styles have a moderate level of reasoning ability by meeting two indicators of reasoning ability and students with auditory learning styles have a high level of ability. low reasoning that only fulfills one indicator, namely making and finding solutions to problems well.

CONCLUSION

Based on the description of the results and the previous discussion, there are several conclusions that can be drawn, including: 1) Grade 11 students of MA Muhammadiyah 1 Plus Malang, have several learning styles, namely: visual, kinesthetic, and auditory, respectively: 67% : 25% : 8%, so that the most dominant learning style in this class is the visual learning style, 2) For students with visual learning styles, students meet several indicators of reasoning abilities including: a) able to present and make written mathematical statements well, b) able to manipulate values and y , and c) develop solutions to existing problems. . 3) For students with a kinesthetic learning style, students meet the indicators of reasoning ability including: a) write mathematical statements well, b) manipulate target functions. 4) Students with auditory learning style only have 1 indicator of reasoning ability, namely: a) making and finding solutions to problems well.

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