UJME 9 (3) 2020: 206-210
UNNES JOURNAL OF MATHEMATICS EDUCATION
https://journal.unnes.ac.id/sju/index.php/ujme/
ISSN: 2252-6927 (print); 2460-5840 (online)

Mathematical reasoning ability of students based on learning style using Missouri Mathematics Project learning model

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ARTICLEINFO

Article history:
Received 18 October 2020
Received in revised form 28 October 2020
Accepted 16 November 2020

Keywords:
Mathematical Reasoning Ability;
Learning Style;
Missouri Mathematics Project

Abstract

The purpose of this study is to (1) determine whether student learning outcomes in aspects of mathematical reasoning ability using the Missouri Mathematics Project learning model achieve classical completeness criteria, (2) describe the mathematical reasoning ability in terms of learning styles using the Missouri Mathematics Project learning model. The method used is mixed methods explanatory sequential design with a population of students in one of senior high school in Demak in the academic year 2019/2020. Samples were taken by cluster random sampling and obtained XI Mathematics dan Science 4 as an experimental class. The research subjects were taken with a purposive sampling technique selected based on the learning style category and obtained 6 subjects. The research data was taken by using test, questionnaire, and interview techniques. The results showed (1) The ability of mathematical reasoning on the application of the Missouri Mathematics Project learning model achieved classical completeness; (2) Two types of visual learning style subjects have mathematical reasoning abilities at the medium and low levels; (3) Two types of auditory learning style subjects have mathematical reasoning abilities at high and low levels; (4) Two types of kinesthetic learning style subjects have mathematical reasoning abilities at high and low levels; (5) The average results of the ability tests for each learning style show that students with auditory learning styles have the highest average.

1. Introduction

Learning innovations in schools have been developed by the Ministry of Education and Culture of the Republic of Indonesia through Permendikbud No. 36 of 2018 concerning Curriculum 2013 SMA / MA, Curriculum 2013 aims to prepare Indonesian people to have the ability to live as individuals and citizens who are faithful, productive, creative, innovative, and affective and able to contribute to the life of society, nation, state and civilization world. That goal can be interpreted that Indonesian people are nothing but students must be able to develop a balance between developing spiritual and social attitudes, curiosity, creativity, cooperation with intellectual and psychomotor abilities. To achieve this goal, learning that was teacher-centered, is now focused on students so that they are able to develop themselves independently and optimally.

Mathematics is one of the subjects that is always studied from an early age even up to tertiary education. That is because mathematics has an important role and benefits in everyday life. Walid (2019) argues that mathematics is a very important scientific discipline in human life because it is the basis for developing other sciences. In studying mathematics, it is inseparable from the nature of mathematics with regard to abstract concepts and ideas arranged in a hierarchical manner so that it requires a gradual understanding designed through the learning process. Meanwhile, Wibowo (2017) argues that by having the ability in mathematics, a person can form a systematic mindset, make reasoning, make guesses, make

To cite this article:
Wahyudi, I. D. & Walid. (2020). Mathematical reasoning ability of students based on learning style using Missouri Mathematics Project learning model. *Unnes Journal of Mathematics Education*, *9*(3), 206-210. doi: 10.15294/ujme.v9i3.44538

careful decisions, be conscientious, be curious, creative, and innovative. In addition, mathematics is a tool used to support the sciences, both in the social, economic, and scientific fields.

Based on the importance of mastery of mathematics by students, then in Permendikbud No. 21 of 2016 concerning Content Standards states that mathematics subjects must meet several competencies such as: (1) Demonstrate logical, critical, analytical, creative, meticulous and thorough, responsible, responsive, and not easily give up in solving problems; (2) Having curiosity, self-confidence, continuous learning enthusiasm, reflective thinking, and an interest in mathematics; (3) Having a sense of trust in the power and usefulness of mathematics, as well as a critical attitude formed through learning experiences; (4) Having the ability to communicate mathematical ideas clearly and effectively; (5) Explain patterns and use them to make predictions and long-term trends; use it to predict trends or check the validity of an argument. In order for students to meet existing competencies, their mathematical abilities need to be improved.

According to Ibrahim in Nu'man (2012), the aim of learning mathematics from elementary to high school is that students have the ability (1) Understanding mathematical concepts, explaining inter-conceptual relationships and applying concepts or algorithms, flexibly, accurately, efficiently, and right, in problem solving; (2) Using reasoning on patterns and traits, carrying out mathematical manipulations in making generalizations, compiling evidence, or explaining mathematical ideas and statements; (3) Solve problems that include the ability to understand problems, design mathematical models, solve models and interpret the solutions obtained; (4) Communicating ideas with symbols, tables, diagrams or other media to clarify the situation or problem; (5) Having an attitude of appreciating the usefulness of mathematics in life, namely having curiosity, attention, and interest in learning mathematics, as well as being tenacious and confident in problem solving. Hendriana (2017: 26) states that in mathematics, mathematical reasoning is a process of mathematical thinking in obtaining mathematical conclusions based on facts or data, concepts, and methods available or relevant. According to Basir in Yusdiana (2018) states that mathematical reasoning can be used as a foundation in understanding and doing mathematics as well as an integral part of problem solving. Reasoning is different from thinking, mathematical reasoning is the most important part of thinking that involves forming generalizations and drawing valid conclusions about ideas and how they relate to them.

Absorption of National Examination for the 2017/2018 Academic Year in mathematics also shows suboptimal results. The national average of the 4 abilities tested (algebra, trigonometry and geometry, calculus, and statistics) only reached 39.2. Meanwhile, according to the Program for International Student Assessment (PISA), the level of student learning outcomes in Indonesia has not yet reached an average score and is still below the rank of developing countries. This is shown by the results in 2000 ranked 39 out of 41 countries with a score of 367, while in 2003 it was ranked 38 out of 40 countries with a score of 360, and in 2006 it was ranked 50 out of 57 countries with a score of 391 (Rahmawati, 2015: 533). Based on 2015 survey results (PISA) in mathematics released by the Organization for Economic Co-operation and Development or OECD (2016), Indonesia ranks 62th out of 70 countries. Indonesia is still below the international average score in mathematics. Indonesia scored 386, while the international average score was 490. Whereas the mathematical problems in the PISA study measured more reasoning ability, problem solving, arguing and communicating than questions that measured standard technical abilities related to memory and calculation alone. Based on the survey results, it can be concluded that the ability of Indonesian students in mathematics is still low.

According to Rahmawati (2015: 534) Factors that cause less optimal student reasoning abilities include internal and external factors. Internal factors are factors found in students which include intelligence, motivation, interests, talents, learning styles, and so forth. While external factors are factors that come from outside the student, including the education system, subject matter, learning models, learning media, facilities and infrastructure, learning environment and so forth.

It has been explained above that learning style is one of the factors that influence student reasoning, thus learning style is also one of the determinants of learning outcomes. According to DePorter and Hernacki in Afif (2016: 329), learning styles are a combination of how he absorbs and then organizes and processes information. In some elementary and secondary schools in America, teachers realize that everyone has an optimal way of learning new information. They understand that some students need to be taught other ways than standard teaching methods. If these students are taught using standard methods, they are less likely to understand what is given. Knowing these different learning styles has helped

teachers everywhere be able to approach all or almost all students simply by conveying information in different styles. Learning styles in question are divided into three types namely visual, auditory, and kinesthetic.

One model of mathematics learning that can be used to train and improve students' mathematical reasoning abilities is the Missouri Mathematics Project (MMP) learning model. According to Agoestanto and Savitri (2013: 72) states that "the Missouri Mathematics Project (MMP) learning model requires students to be active in learning because the teacher is only a facilitator who assists and only helps students find their knowledge". The Missouri Mathematics Project learning model trains students to be independent, collaborate, and reason in solving mathematical problems.

The Missouri Mathematics Project learning model has steps in its implementation namely, review, development, group / cooperative work, seatwork, and homework. The characteristics of the Missouri Mathematics Project learning model are homework, where the homework is expected to be able to improve mathematics learning outcomes and students' mathematical reasoning abilities.

Based on the results of research that has been carried out by Agoestanto and Savitri (2013) with the Missouri Mathematics Project learning model and the ability studied is the problem solving ability of junior high school students, it is concluded that (1) the problem solving ability of students with mathematics learning refers to the Missouri Mathematics Project complete classically, (2) the average problem solving ability of students with mathematics learning that refers to the Missouri Mathematics Project is higher than the average problem solving ability of students with expository learning models, and (3) the average student activity with mathematics learning which refers to the Missouri Mathematics Project is higher than the average student activity with expository learning models. Based on these three results, Agoestanto et al concluded that learning mathematics that refers to the Missouri Mathematics Project is effective learning. Therefore, that mathematics learning that refers to MMP can be used as an alternative learning in other mathematical material that can be chosen by the teacher.

Rivai and Surya (2017) also conducted research related to the Missouri Mathematics Project model with the ability being tested was students' mathematical reasoning abilities. Based on the results of research and data analysis, it can be concluded that the mathematical reasoning ability of students who learn with the Missouri Mathematics Project learning model is better than students who learn with conventional strategies in junior high school students.

The hypothesis to be tested in this study is the results of student learning in the aspect of mathematical reasoning ability in the Missouri Mathematics Project learning model achieving classical completeness criteria.

2. Methods

This type of research used in this study is a mixed or mixed methods research with explanatory sequential design. According to Creswell (2015: 1102), explanatory sequential design is a research design that combines quantitative and qualitative methods in sequence, with the first stage conducting quantitative research and after that carried out with qualitative methods. In this study, quantitative data about the results of tests of mathematical reasoning ability in the Missouri Mathematics Project learning are analyzed first, then an analysis of qualitative data will be conducted, namely the results of student learning style questionnaires obtained from interviews of research subjects.

The population in this study were all students of XI Mathematics and Science one of senior high school in Demak in the academic year 2019/2020. The type of class sampling in this study is cluster random sampling. While the selection of research subjects by purposive sampling is to take the subject not based on strata, random, or region but based on certain objectives. The Missouri Mathematics Project is conducted in the experimental class XI Mathematics and Science 4 for three meetings and one meeting for reasoning ability tests mathematical and one meeting for an interview.

Analysis of the data used is the normality and homogeneity test as the initial data analysis for cluster random sampling, whereas for the analysis of the data the mathematical reasoning ability test consists of 2 tests namely the normality test with Liliefors and the one-party proportion test, namely the right party to test classical completeness tests mathematical reasoning ability.

3. Results and Discussion

Preliminary data analysis using the results of the previous chapter's repetition of mathematical induction of all students XI Mathematics dan Science in one of senior high school in Demak consisting of XI Mathematics and Science 1 to XI Mathematics and Science 4, obtained the results that each class came from a population that was normally distributed and homogeneous. This is in accordance with the opinion of Arikunto (2013: 175), "a new sample study may be carried out if the condition of the subjects in the population is truly homogeneous". Then from the four classes, the class with normality value was chosen not much different as the test class and the experimental class, obtained XI Mathematics and Science 3 as a trial class and XI Mathematics and Science 4 class as an experimental class.

The experimental class was given treatment by using Missouri Mathematics Project learning on linear two-variable program material. The advantages of this model are conveyed by Irnistisia (2016: 71) that the Missouri Mathematics Project (MMP) learning model requires students to be able to present problems and find strategies in order to solve mathematical problems they face both in groups and individually.

Based on the results of tests of mathematical reasoning ability after learning with the Missouri Mathematics Project learning, 24 of 27 students achieved mastery learning individually, or about 88.89% of students in the experimental class. Based on the results of hypothesis 1 test on classical completeness, it was found that as many as more than or equal to 75% of students obtained grades that achieved Minimum Criteria Completeness on a mathematical reasoning ability test. So the mathematical reasoning ability in learning Missouri Mathematics Project has reached classical learning completeness. These results are consistent with Rivai's research (2017) which says that the mathematical reasoning ability of students who learn with the Missouri Mathematics Project learning model is better than students who learn with conventional strategies.

Based on the results of tests of mathematical reasoning ability and grouping of learning styles that have been done, obtained 5 students of visual learning style types with an average value of 76.8 and standard deviation of 9.12, 13 students of auditory learning style types with an average value of 79.8 and standard deviation 10.01, and 6 students type kinesthetic learning style with an average value of 76.2 and standard deviation 6.76. If observed based on the standard deviation of each learning style, it can be seen that the data distribution is quite varied because each style has a high standard deviation, especially for students in auditory learning styles. Difference in the average value of the three learning styles shows that the difference in learning outcomes is not too significant, but it can be noted that the average value of students with auditory learning styles is the highest compared to other learning styles even though it includes twice as many students. Of course for this research it can be said that the Missouri Mathematics Project Learning Model is quite successfully applied to students with auditory learning style types.

Qualitative discussion in this study discusses the results of the analysis that has been explained previously about students' mathematical reasoning abilities in terms of learning styles. The following will be presented a summary of the mathematical reasoning ability analysis of 6 selected subjects consisting of subjects V-01 and V-02 for visual learning styles, subjects A-01 and A-02 for auditory learning styles, and subjects K-01 and K-02 for the kinesthetic learning style presented in Table 1 as follows.

Table 1. Summary of Qualitative Analysis of Mathematical Reasoning Ability

Learning Styles	Subject Code	Indicator				Reasoning Ability
		1	2	3	4	
Visual	V-01	A	A	LA	LA	Medium
	V-02	A	LA	UA	LA	Low
Auditory	A-01	A	A	UA	A	High
	A-02	A	LA	UA	LA	Low
Kinesthetic	K-01	A	A	LA	A	High
	K-02	A	LA	UA	LA	Low

Note :
A : Able; LA : Less Able; UA : Unable

4. Conclusion

Based on the results of research that has been done, it can be concluded (1) The ability of mathematical reasoning on the application of the Missouri Mathematics Project learning model achieves classical completeness; (2) Two types of visual learning style subjects have mathematical reasoning abilities at the medium and low levels; (3) Two types of auditory learning style subjects have mathematical reasoning abilities at high and low levels; (4) Two types of kinesthetic learning style subjects have mathematical reasoning abilities at high and low levels; (5) The average results of the ability tests for each learning style show that students with auditory learning styles have the highest average.

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