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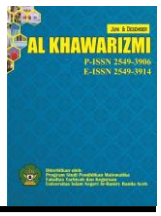

STUDENTS' MATHEMATICAL REPRESENTATION ABILITY IN SOLVING DIVERGENT PROBLEMS IN TERMS OF LEARNING STYLE

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Abstract

This study uses a qualitative approach with a descriptive purpose to find out how each learning style affects students' ability in mathematical representation. The research took place at SMP Kartika XIX-2 Bandung in class VII, with the research subjects totaling six students: two students each with visual, auditory, and kinesthetic learning styles. The research instrument used the main instrument, namely the researcher himself, and supporting instruments in the form of divergent questions and interview questionnaires. The results obtained are as follows: (1) subjects with visual learning styles were able to fulfill the symbolic and visual mathematical representation indicators well but lacked verbal indicators; (2) subjects with auditory learning styles were able to fulfill the symbolic and verbal mathematical representation indicators well but lacked in visual indicators; and (3) subjects with kinesthetic learning styles were able to fulfill the symbolic mathematical representation indicators quite well but were very lacking in visual and verbal indicators.

INTRODUCTION

Mathematical ability is important in students' intellectual development and thinking abilities (Rahmanisa et al., 2020). Mathematics is a series of concepts and theories and the application of concepts in real-world situations (Wasqita et al., 2022). According to Fatri et al., (2019), Mathematical representation, as an important aspect of understanding mathematics, highlights students' abilities to describe, interpret, and solve mathematical problems through various methods, such as graphs, tables, diagrams, or mathematical formulas.

Mathematical representation skills are very important in the mathematics learning process. By having good representation skills, students can more easily understand and solve mathematical problems effectively. This helps students broaden their understanding of mathematical concepts and improves problem-solving skills (Hidayati, 2023).

According to NCTM in summary (Allen et al., 2020), mathematical ideas can be represented in various ways: pictures, concrete objects, tables, graphs, numerical symbols, and letters. These ways of representing mathematical ideas are essential for understanding and using those ideas. Many of the representations we now take for granted result from cultural refinement over many years. When students gain access to mathematical representations and the ideas they express and when they can create representations to capture mathematical concepts or relationships, they acquire a set of tools that significantly expand their capacity to model and interpret physical, social, and mathematical phenomena (Prayitno et al., 2021). Mathematical representation skills are essential in today's educational context as they provide students with the tools necessary to understand, interpret, and solve mathematical problems more effectively.

According to Saputra (2021), representation skills play a key role in solving mathematical problems, including complex, divergent problems. Moreover, in line with Krisnawati (2021), Each student has a unique learning style in understanding and solving mathematical problems, especially divergent mathematics, where divergent mathematical problems have many possible answers to one question that requires students to use critical abilities and mathematical representations, also requires students to solve divergent problems in the form of visualization, verbalization, and symbolic manipulation.

In addition to mathematical representation ability, according to (Natonis et al., 2022), students' learning styles also play an important role in the mathematics learning process. According to Hidayat (2020), Learning styles that differ from student to student can affect how they absorb information, process mathematical concepts, and solve problems. Some students prefer to learn through visualization or simulation, while others prefer an auditive or kinesthetic approach.

Learning style is an approach to understanding how individuals process information and learn. The way a person concentrates on the learning process and makes sense of new and complex material from multiple perspectives. Each individual has a unique learning style, reflecting differences in personality, behavior, beliefs, and preferences. In general, learning styles refer to an individual's preference in using various methods and strategies to aid their learning process in a given situation (Hidayati et al., 2023). The learning styles discussed in this study are visual, auditory, and kinesthetic.

This research is expected to provide a deeper understanding of the relationship between students' mathematical representation skills in solving divergent problems regarding their learning styles. The results of this study are expected to provide valuable input for developing more effective and inclusive mathematics learning strategies and improving students' mathematical understanding and skills.

RESEARCH METHODS

This research uses a qualitative approach with descriptive purposes. The descriptive purpose is to provide a complete picture of a situation or phenomenon that occurs as it is. This method is used because it is in line with the research objectives, namely to get an in-depth and detailed description of students' mathematical representation abilities in solving divergent problems in terms of learning styles.

The main instrument in this research is the researcher himself. In the research process, the researcher acts as a data collector, reducer, and presenter (Yarmayani, 2024). Supporting instruments used include learning style questionnaires, divergent math problems, and interview guidelines.

The research was conducted on Tuesday, April 30, 2024, at SMP Kartika XIX-2 Bandung in class VII. The research subjects were six students selected from 23 students based on a learning style questionnaire consisting of 14 questions. After that, students were given three divergent math problems covering geometry and linear equations, which contained indicators of mathematical representation. From a series of tests and certain considerations, the researcher selected two students with visual learning styles, two students with auditory learning styles, and two students with kinesthetic learning styles. The research ended with an interview.

Supporting instruments, such as a learning style questionnaire, divergent questions, and interview guide, were developed and tested with the following steps:

Development of Learning Style Questionnaire: This questionnaire consists of 14 questions designed to identify students' learning styles (visual, auditory, and kinesthetic). The questionnaire was pilot-tested on a different group of students to ensure its validity and reliability. Divergent Problem Development: The divergent problems covered geometry and linear equations, which contained mathematical representation indicators. These problems were developed concerning relevant literature and piloted on a group of students to ensure suitability and appropriate level of difficulty. Interview Guide Development: An interview guide was developed to dig deeper into students' understanding of their thought processes when solving divergent problems. This guide was tested with several students to ensure that the questions asked were well understood and adequate to extract the information needed.

From the modification result of Saputra (2021), The criteria for mathematical representation ability can be seen in Table 1 below.

Table 1. Criteria for Mathematical Representation Ability

Indicator	Criteria
Symbolic representation ability	The subject uses mathematical symbols and models to solve the problem correctly and completely, so the subject has used the symbolic representation indicator.
Visual representation ability	The subject describes the problem with a picture completely, sequentially, and correctly, so the subject has used the visual representation indicator.
Verbal representation ability	The subject makes the story problem into a sentence form that is logical, precise, and correct, so the subject uses the verbal representation indicator.

RESEARCH RESULTS AND DISCUSSION

a. Visual Learning Style

In solving divergent problems that contain indicators of symbolic representation ability, subject IK with a visual learning style can answer the problem properly and correctly, along with

two other possible answers. This is also confirmed by the interview results, namely, the subject IK can explain how to answer this problem by finding the volume of the beam and the three possible sizes of the other beam's length, width, and height.

In solving divergent problems that contain indicators of visual representation ability, subject IK can describe the known information in the problem correctly, along with two other possible answers. The interview results also confirm this; the subject IK can explain how to answer this question by describing the size of different cubes with triangles. This is reinforced by research (Wasqita & Sukoriyanto, 2023) that subjects with visual learning styles are very good at solving math problems with visual mathematical representation indicators. Also, (Hasanah, 2023) subjects with visual learning styles are very good at presenting information through images.

In solving divergent problems that contain indicators of verbal representation ability, subject IK tends to have difficulty making story problems in everyday life, along with two other possible answers. The interview results also confirm this: the IK subject still mistakenly determines the question from the problem, and the mathematical variables cannot be fully translated into words. Also, in line with research (Azzahra & Sopiany, 2022), subjects with visual learning styles have difficulty making words when solving math problems. This can be seen in Figure 1.

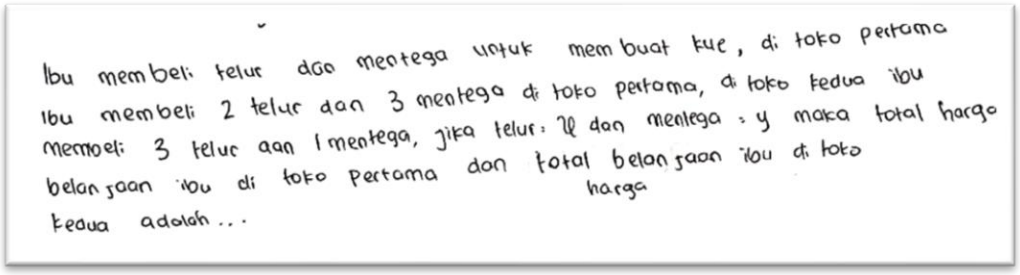

Figure 1.
Subject IK's work on verbal representation ability indikator

b. Auditory Learning Style

In solving divergent problems with symbolic representation ability indicators, CS subjects with auditory learning styles can answer the problem properly and correctly, along with two other possible answers. The interview results also confirm this: the CS subject can explain how to answer this problem by finding the volume of the beam and the three possible sizes of the other beam's length, width, and height. This aligns with research (Ramadhana et al., 2022) that subjects with auditory learning styles easily solve symbolic representation problems.

In solving divergent problems that contain indicators of visual representation ability, CS subjects tend to have difficulty describing the information known in the problem. The interview results also confirm this: the CS subject painted a cube but did not connect the triangles in the cube and only made one other cube that contained a triangle. This can be seen in Figure 2.

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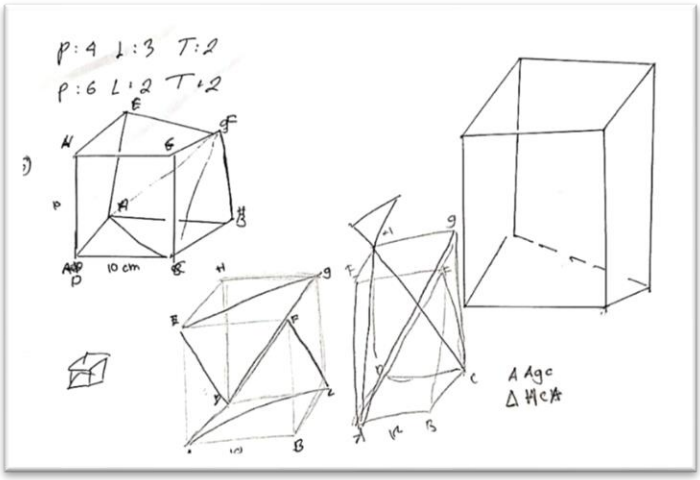

Figure 2.
CS subject's work on visual representation ability indicators

In solving divergent problems that contain indicators of verbal representation ability, subject CS makes story problems in everyday life along with two other possible answers. However, some things are still wrong. The interview results also confirm this; for the first problem that the CS subject made, he could explain the memorization in everyday life and make two story problems, but for the second problem, he still made mistakes in determining the question of the question. This also aligns with research (Hasanah, 2023) that subjects with auditory learning styles are quite good at answering questions in words.

c. Kinesthetic Learning Style

In solving divergent problems that contain indicators of symbolic representation ability, DM subjects with kinesthetic learning styles have slight problems constructing answers. However, they are correct in making two other possible answers. The interview results also confirm this; namely, the DM subject is less able to show how to find the volume of the beam but is correct in making two other possible answers. This is in line with research (Hasanah, 2023) that subjects with kinesthetic learning styles will have difficulty making mathematical models of the problems contained in the problem.

In solving divergent problems that contain indicators of visual representation ability, DM subjects tend to have difficulty describing the information known in the problem. The interview results also confirm this: the DM subject only makes two cubes containing one triangle inside and does not describe two different sizes of cubes containing two triangles in the cube. This is in line with research (Ramadhana et al., 2022) that subjects with kinesthetic learning styles have difficulty drawing math problems into the form of geometric shapes. This can be seen in Figure 3.

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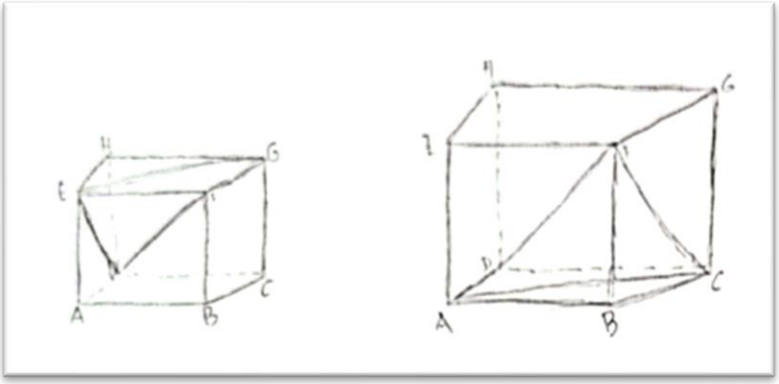

Figure 3.
DM subject's work on visual representation ability indicator

In solving divergent problems that contain indicators of verbal representation ability, DM subjects tend to have difficulty making story problems in everyday life, along with two other possible answers. This is also confirmed by the interview results, namely for the first and second answers, the DM subject still mistakenly memorizes the mathematical variables in the context of the words of the problem, but the question is correct. This is in line with (Azzahra & Sopiany, 2022) that subjects with kinesthetic learning styles find it difficult to write down words in solving mathematical problems. In solving mathematical problems. This can be seen in Figure 4

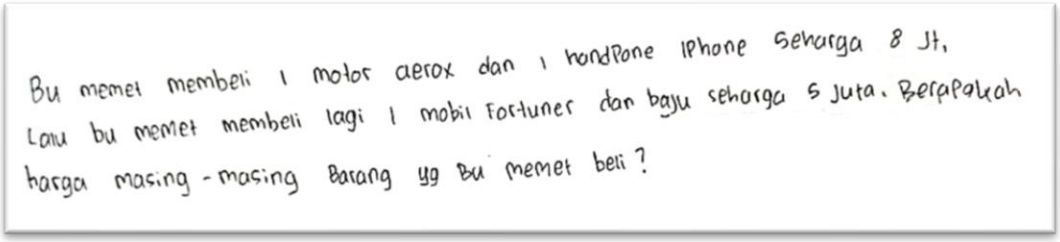

Figure 4.

DM subject's work on verbal representation ability indicator

CONCLUSION

Mathematical representation skills are very important in today's education because they help students understand, interpret, and solve mathematical problems more effectively. Based on the research results, subjects with visual learning styles were able to fulfill the symbolic and visual mathematical representation indicators well but lacked verbal indicators. Subjects with auditory learning styles were able to fulfill symbolic and verbal indicators well but lacked visual indicators.

Subjects with kinesthetic learning styles were able to fulfill the symbolic indicator quite well but were very lacking in the visual and verbal indicators. The practical implication of these results shows the importance of implementing learning strategies that suit students' learning styles: Visual Use visual aids such as diagrams, graphs, and animated videos. Auditory Includes class discussions, lectures, and auditory aids such as sound recordings. Kinesthetic Use physical activities and object manipulation, such as props and educational games.

Therefore, the researcher suggests that other researchers with similar fields and interests continue this research to explore the factors that cause obstacles to students with different learning styles in solving math problems. By doing so, it is hoped that a solution can be found that suits the needs of students according to their learning styles. This further research can contribute to the development of more effective and inclusive teaching methods in mathematics education, which will ultimately improve the mathematical understanding and skills of all students.

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