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Analyzing Students' Mathematical Representation Skills in Probability Based on Learning Style Variations

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Abstract: Describe the mathematical representation of each student's learning style in solving probability material problems. The research form used is qualitative research. The subjects of the study were students of class VIII A of SMPN 3 Ngawi who had studied probability topic. The research data came from written tests and interviews. Subjects with visual learning style have sufficient ability in word representation, less in visual representation, both in pictorial and symbolic representation. Subjects with auditory learning style have sufficient ability in word and symbolic representation, both in visual and pictorial representation. Subjects with read/write learning style have insufficient ability in word representation, both in visual representation, sufficient in pictorial and symbolic representation. Subjects with kinesthetic learning style have sufficient ability in word, visual and pictorial representation and less in symbolic representation.

Keywords: mathematical representation, probability, learning style.

▪ INTRODUCTION

Mathematics is one of the general sciences which has an important role in human life. Every student is required to study Mathematics because this knowledge will always be used in continuing to a higher level of education, and can even be applied in everyday life. The importance of studying Mathematics makes efforts to improve the quality of Mathematics learning need to be carried out continuously.

Efforts to improve mathematics learning need to be carried out comprehensively so that learning objectives can be achieved. The National Education Standards Agency (2006) explained that "the general objective of mathematics learning is so that students can have abilities such as understanding, reasoning, problem solving, communication, and an attitude of appreciating the usefulness of mathematics in life" . This goal further strengthens the importance of providing quality Mathematics learning. This subject will be very useful for students to have the ability to understand and solve problems using Mathematical logic. (Nurdiansyah, 2017) stated that "Mathematics learning is expected to end with a comprehensive student understanding. The expected student understanding is not only to fulfill the objectives of mathematics learning substantively but also expected to have accompanying effects from the learning". This accompanying effect can be in the form of better logic, students becoming more innovative and creative in dealing with problems, being able to combine mathematics with other fields, and so on.

One form of mathematical ability is mathematical representation. Instructions from the Ministry of Education, Culture, Research and Technology (2022) state that the purpose of learning mathematics is to communicate ideas with symbols, tables, diagrams, or other media to clarify a situation or problem, and to present a situation into a mathematical symbol or model (mathematical communication and representation). Mathematical representation is an important aspect of mathematics learning. Mathematical representation is related to the process of creating and using symbols,

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tables, diagrams, or other forms to communicate mathematical ideas and modeling. This process also includes flexibility in changing from one form of representation to another, and choosing the most appropriate representation to solve the problem (Kemendikbudristek, 2022,. Representation is considered a part of mathematical communication (Ririn, 2022). (Hariyani, 2023) Mathematical representation ability serves as a bridge that connects students to understand other mathematical abilities. This means that when students have mastered and can develop mathematical representation ability effectively, they will easily grasp other mathematical abilities. In other words, mathematical representation ability is the key to mastering other mathematical abilities. Mathematical representational ability is one of the competencies that must be achieved in learning mathematics (Hidayat, 2023). However, in essence, mathematical representation have an urgent position to pay attention to. Mathematical representation ability also helps students in building and understanding concepts, expressing mathematical ideas, and also makes it easier for students to develop their abilities.

The achievement of learning objectives is determined by the accuracy in choosing learning that is in accordance with the differentiation of student characteristics. To respond to these different learning styles, educators use different learning processes, media or content to achieve their learning goals (Uci, 2023). Learning style is one of the important aspects in the field of education in order to realizing successful defense. For this reason, students need to know what kind of learning style is compatible with them (Rahayu 2022). So basically learning style is the easiest way for an individual to learn something. (Afshari 2023) states that learning styles are characteristic of various cultures, learners with different cultural backgrounds show diverse perceptual patterns of learning styles preferences.

Previous research by Zulfah and Rianti (2018) found that in the visual representation ability of table presentation, students were able to re-present data or information from a table into other forms such as row patterns. In this representation, there are various forms or patterns that are given so that they show good visual representation skills. Visual representation ability of images where students make pictures of geometric parts to solve problems and facilitate problem solving. The ability of symbolic representation or mathematical equations or expressions possessed by students is already possessed by almost all students. The previous research findings above show the importance of students' mathematical representations. Without exerting representation, students will not easily solve various problems of algebra, geometry, and linear equations because they cannot easily imagine problems without first representing them (Hadijah, 2021). Learning styles are characteristics that are considered primarily in selecting the most appropriate learning methods, techniques, and strategies. Related to learning styles as an important consideration in choosing strategies or learning models, the researchers applied visualization, auditory, kinesthetic (VAK) models in learning writing skills since through this model, students were given the flexibility to learn according to their learning styles (Kusumawarti, 2020).

The learning style of each individual student is basically different. The difference in learning styles is thought to affect student learning outcomes. This condition needs to be considered by teachers in order to know the right steps to improve student learning outcomes. Learning style of presenting something which students prefer in Learning (Anthony, 2019). Learning style is the easiest way for individuals to absorb, organize and process the information received. This is in accordance with the opinion of various student learning styles aim to make students learn comfortably and can be expected to

achieve their learning goals well (Frita 2018). The ability of mathematical representation is the ability of students to use and connect between representations in the form of symbols, images, mathematical expressions, and written text as achievements of their minds to find solutions. Students are expected to be able to make representations in the form of mathematical drawings to communicate their mathematical ideas in solving problems in revival and harmony materials (Widiyastuti, 2022)

In mathematics learning at junior high school level, the average student has learning problems in certain subjects. The results of an initial interview with Mrs. Wulan, as one of the mathematics teachers at SMPN 3 Ngawi, obtained information that students have learning problems in the material of probability. The material of probability requires conceptual understanding and using logical thinking. Understanding of this material of probability can be improved by improving mathematical representation skills. The mathematical representation skills of each student need to be known in order to overcome the learning problems of the material of probability. Differences in the mathematical representation skills of individual students need to be analyzed based on the students' learning styles. Diverse learning styles are thought to have an impact on students' mathematical representation skills. Each component of learning style has its own characteristics, namely (1) visual, including learning with graphs, diagrams, pictures, or mind mapping, liking to underline words that are considered important in books, liking to color important notes, illustrating notes that are full of writing into graphs, diagrams, pictures, or mind mapping, and being less able to take notes completely when the teacher explains; (2) auditory, including easily receiving information just by listening to the explanation given by the teacher, being able to express opinions well, enjoying discussions, and reading aloud; (3) read/write, including easily receiving information by reading, liking to rewrite what is in books, recording information given by the teacher neatly and in detail, and tending to read quietly; and (4) kinesthetic, including liking to do a lot of movement when studying, liking to walk back and forth when memorizing something, taking lots of breaks when studying, and preferring real work or practice (Ilham, 2021).

▪ METHOD

The research form used is qualitative. According to Sugiyono (2017), Qualitative research method is a research method based on the philosophy of positivism, used to research the natural conditions of objects, where the researcher is the key instrument. This qualitative research is used to obtain facts related to the ability of mathematical representation in the material of probability reviewed from the learning style of SMPN 3 Ngawi students. The research strategy used is a case study. Case studies are an effective means of showing the relationship between researchers and respondents. The qualitative case study method is a model that emphasizes the exploration of a system that is related to each other. The selection of this case study strategy was carried out to answer the previously established problem formulation.

The subjects of this study were 30 students of class VIII A of SMP Negeri 3 Ngawi, consisting of 19 female students and 11 male students. This study will discuss the ability of mathematical representation in the material of probability in terms of the learning styles of SMPN 3 Ngawi students. The determination of the subjects of this study used purposive sampling. Sugiyono (2017) argues that "Purposive sampling is a technique for determining samples with certain considerations". Not all students of class VIII A were used as research subjects. The subjects of the study were determined based

on the results of the questionnaire determining the students' learning styles. Each learning style is represented by two students who are determined with the consideration that the measurement of mathematical representation abilities can be represented by each learning style applied by the students.

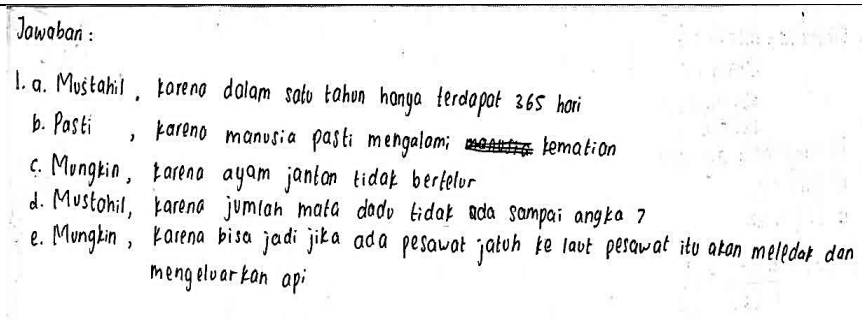
This research used indicators of mathematical representation, namely: Word representation, which is solving problems with word explanations. Visual representation, which is using visual information provided to solve problems. Image representation, which is presenting mathematical representations in the form of images to solve problems. Symbolic representation, namely writing equations or formulas and carrying out calculations for the given problems.

The validity of the data is carried out by the data triangulation technique. According to (Sugiyono, 2017), triangulation is defined as a data collection technique that combines various data collection techniques and existing data sources. (Alfansyur and Mariyani, 2020) the meaning of this time triangulation is that often time also affects the reliability of data. For example, data collected in the morning with interview techniques where at that time the interviewees were still fresh and there were not many problems, will provide more valid data so that it is more credible. Qualitative data analysis in this study using the Miles and Huberman model is data reduction. The presentation of data was carried out with a brief description containing data from the interview. The conclusion in the qualitative research that is expected is a new finding that has never existed before.

▪ RESULT AND DISCUSSION

The research data taken in this research is based on the results of learning style tests and mathematical representation tests. The results of the learning style test are analyzed to determine the type of subject's learning style. Based on the results of the learning style test, it will be used to group the mathematical representation abilities of each learning style. After determining the student's learning style, a mathematical representation test will be carried out. To obtain the results of the mathematical representation ability test, a written test and an interview test are used. The subjects given the mathematical representation test are two subjects from each of the learning styles that have been determined. The following are the written test and the mathematical representation interview. The results of mathematical representation test data are generally divided into several types;

Table 1. Mathematical representation test data number 1

No	Description	Test Result Data
1	The correct answer and the reason given are also appropriate.	 Jawaban : 1. a. Mustahil, karena dalam satu tahun hanya terdapat 365 hari b. Pasti, karena manusia pasti mengalami ~~meninggal~~ kematian c. Mungkin, karena ayam jantan tidak bertelur d. Mustahil, karena jumlah mata dadu tidak ada sampai angka 7 e. Mungkin, karena bisa jadi jika ada pesawat jatuh ke laut pesawat itu akan meledak dan mengeluarkan api

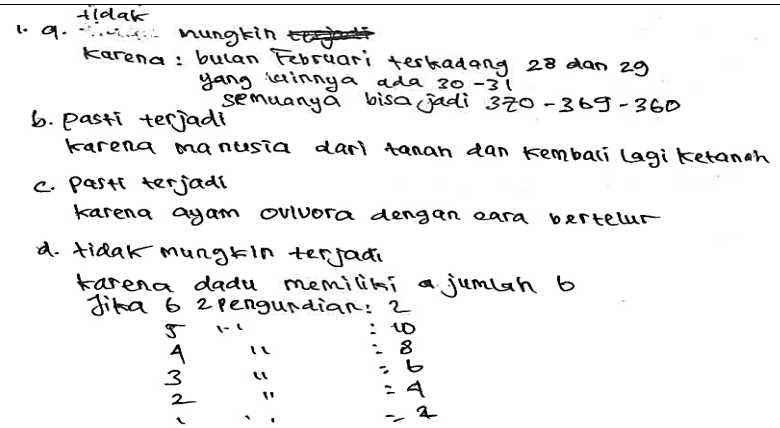
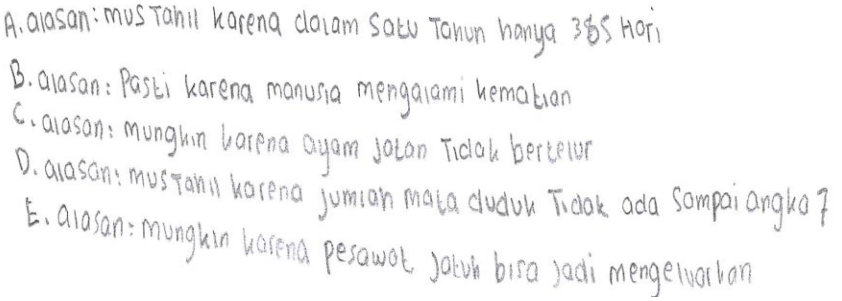
The answer is correct but gives a less clear explanation.	
Incorrect answers and incorrect reasons	

Table 2. Mathematical representation test data number 2

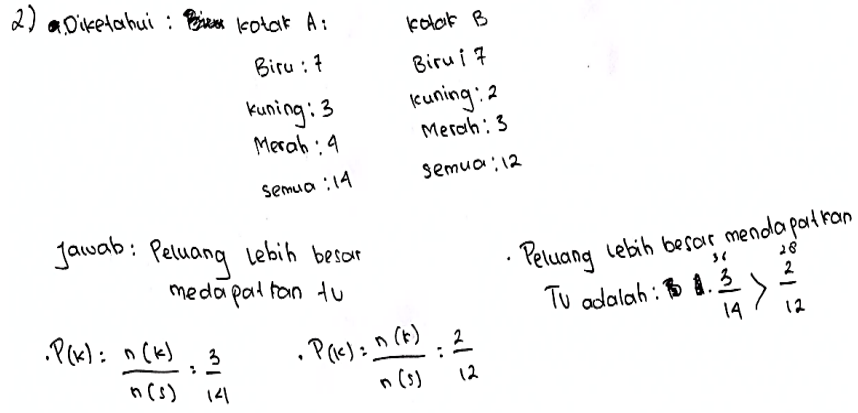
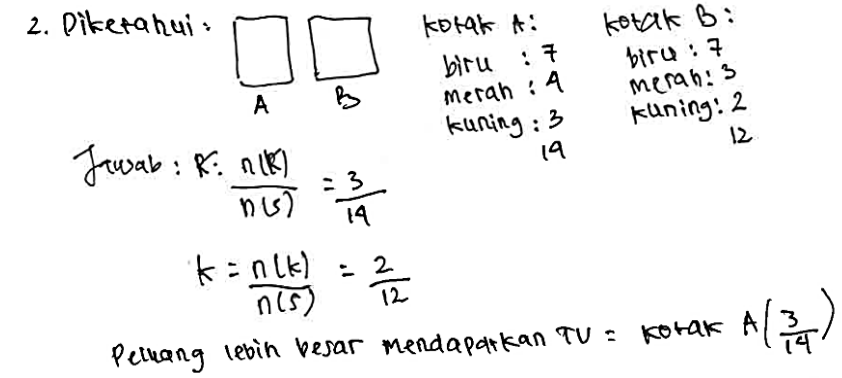
No	Description	Test Result Data
2	The method and formula used are correct and the right answer.	
	The answers and formulas are correct but there are ways that are not written.	

Table 3. Mathematical representation test data number 3

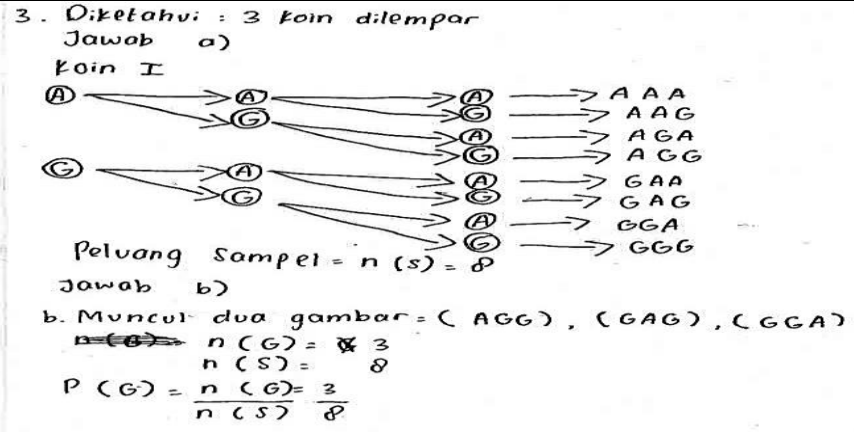
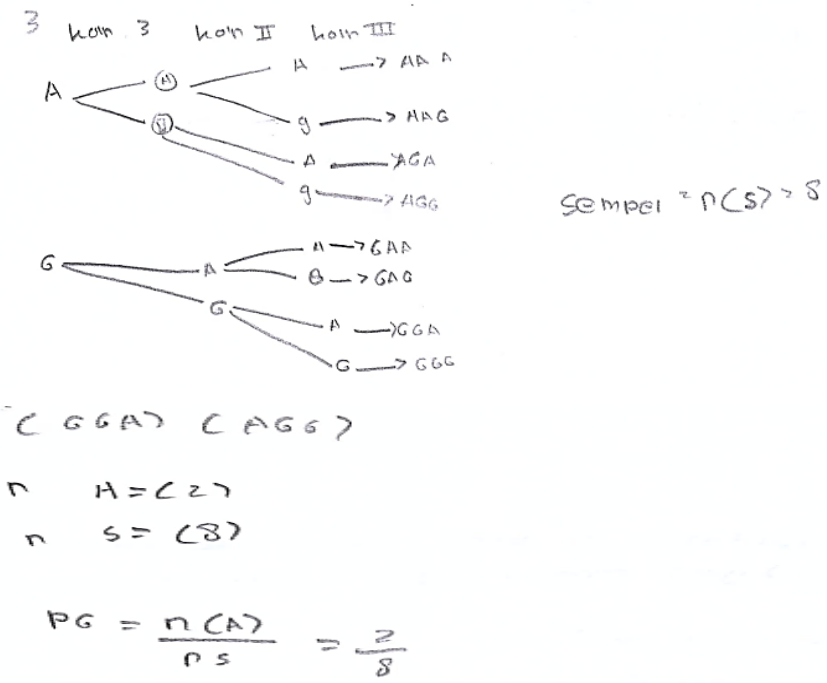
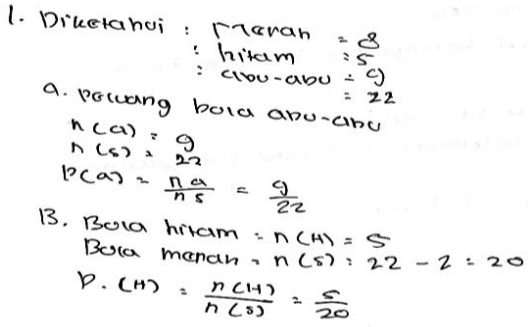
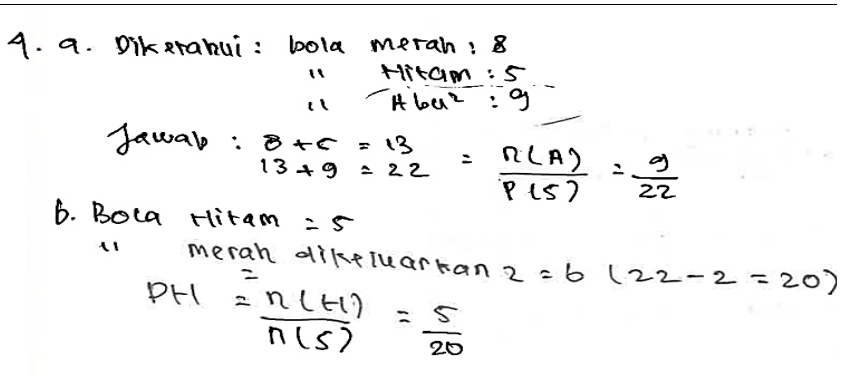
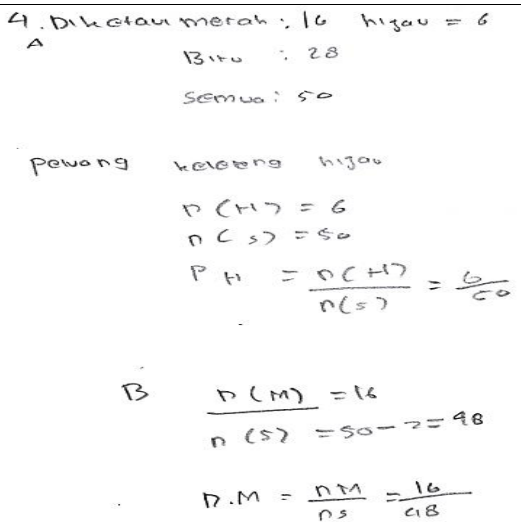
No	Description	Test Result Data
3	Fully drawn graphs and correct answer formulas	
	The graph is drawn completely but the formula and answer are not right	

Table 4. Mathematical representation test data number 4

No	Description	Test Result Data
4	The correct answer and the formula used are written in full	

The answer is correct but the formula written is incomplete	
The answers are incorrect and the data information from the questions is also inaccurate.	

Read/Write Learning Style Subjects

Subject A1 and Subject A2 are subjects who has been given a learning style test and a written mathematical representation test. Subject A1 is determined based on the results of the learning style test that has been given. Subject A1 gets the highest score in the read/write learning style. The following are the results of the representation test for subject A1 data 1 and data 2:

Word Representation Skills

The results of the written test for subject A1 for number 1 are: The answer is correct but gives a less clear explanation. The results of the written test for subject A2 for number 1 are: Incorrect answers and incorrect reasons. The results of time triangulation and data analysis of word representation ability are that Subject A1 and Subject A2 were less able to understand the given problem and only answered some of the possible chance events correctly. Subject A1 and Subject A2 were less able to explain the reasons for the chance events and only explained some of the chance events clearly.

Visual Representation Skills

The results of the written test for subject A1 for number 2 are: The answers and formulas are correct but there are ways that are not written. The results of the written test for subject A2 for number 2 are: The method and formula used are correct and the right answer. The results of time triangulation and data analysis visual representation ability are, Subject A1 and Subject A2 are able to understand the given chance event problems.

Subject A1 and Subject A2 write down some information from the problem picture, are able to solve chance event problems, solve the given problems with the information obtained in the picture.

Image Representation Ability

The results of the written test for subject A1 for number 3 are: Fully drawn graphs and correct answer formulas. The results of the written test for subject A2 for number 3 are: Fully drawn graphs and correct answer formulas. The results of time triangulation and data analysis of the ability to represent images are that Subject A1 and Subject A2 are quite capable of understanding the given problem well and can present a good tree diagram image from the information provided in the question.

Symbolic Representation Skills

The results of the written test for subject A1 for number 4 are: The answer is correct but the formula written is incomplete. The results of the written test for subject A2 for number 4 are: The correct answer and the formula used are written in full. The results of time triangulation and data analysis of the ability to represent images are that Subject A1 and Subject A2 are quite capable of understanding the given problem well, presenting information from the given question, writing down the number of marbles of each colour then answering the question correctly and writing down the equation or formula and doing calculations from the given problem.

Visual Learning Style Subjects

Subject B1 and Subject B2 are a subjects who has been given a learning style test and a written mathematical representation test. Subject B1 is determined based on the results of the learning style test that has been given. Subject B1 gets the highest score in the auditory learning style. The following are the results of Subject B1's mathematical representation ability test:

Word Representation Ability

The results of the written test for subject B1 for number 1 are: Incorrect answers and incorrect reasons. The results of the written test for subject B2 for number 1 are: Incorrect answers and incorrect reasons. The results of time triangulation and data analysis of word representation ability are that Subject B1 and Subject B2 are quite able to understand the given problem and only answer some of the possible chance events correctly. Subject B1 and Subject A2 can determine chance events but are less precise in explaining the reasons in words.

Visual Representation Ability

The answer results from the written test for subject B1 for number 2 are: The method and formula used are correct and the right answer. The results of the written test for subject B2 for number 2 are: The method and formula used are correct and the right answer. The results of time triangulation and data analysis visual representation ability are. Subject B1 and Subject B2 are able to understand the given chance event problems. Subject B1 and Subject B2 write down some information from the problem picture and then solve the given problem from the information obtained in the picture

Image Representation Ability

The results of the written test for subject B1 for number 3 are: Fully drawn graphs and correct answer formulas. The results of the written test for subject B2 for number 3 are: Fully drawn graphs and correct answer formulas. The results of time triangulation and data analysis of the ability to represent images are, Subject B1 and Subject B2 are able to understand the given problem well and can present a good tree diagram image from the information provided in the question. Subject B1 and Subject B2 present a complete tree diagram image and can solve the problem using the correct information.

Symbolic Representation Ability

The results of the written test for subject B1 for number 4 are: The correct answer and the formula used are written in full. The results of the written test for subject B2 for number 4 are: The correct answer and the formula used are written in full. The results of time triangulation and data analysis of symbolic representation ability are, Subject B1 and Subject B2 are quite capable of understanding the given problem well, presenting information from the given question, writing down information from the question then being able to answer correctly and writing down the equation or formula and doing calculations from the given problem but do not provide a description of the symbol in the formula they wrote.

Auditory Learning Style Subjects

Subject C1 and Subject C2 are subjects who has been given a learning style test and a written mathematical representation test. Subject C1 is determined based on the results of the learning style test that has been given. Subject C1 gets the highest score in the visual learning style. The following are the results of Subject C1's mathematical representation ability test:

Word Representation Ability

The results of the written test for subject C1 for number 1 are: The correct answer and the reason given are also appropriate. The results of the written test for subject C2 for number 1 are the correct answer and the reason given are also appropriate. The results of time triangulation and data analysis of the word representation ability are that Subject C1 and Subject C2 are quite able to understand the problems given and only answer some of the possible chance events correctly. Subjects C1 and C2 can determine chance events but are less precise in explaining the reasons in words.

Visual Representation Ability

The answer results from the written test for subject C1 for number 2 are: The method and formula used are correct and the right answer. The results of the written test for subject C2 for number 2 are: The method and formula used are correct and the right answer.

The results of time triangulation and data analysis of visual representation ability are Subject C1 and Subject C2 were less able to understand the given chance event problem. Subject C1 and Subject C2 wrote down some information from the problem picture and then solved the given problem from the information obtained in the picture.

Image Representation Ability

The results of the written test for subject C1 for number 3 are: Fully drawn graphs and correct answer formulas. The results of the written test for subject C2 for number 3 are: Fully drawn graphs and correct answer formulas. The results of time triangulation and data analysis of the ability to represent images, namely, Subject C1 and Subject C2 are able to understand the given problem well and can present a good tree diagram image from the information provided in the question. Subject C1 and Subject C2 present a complete tree diagram image and can solve the problem using the correct information.

Symbolic Representation Ability

The answer results from the written test for subject C1 for number 4 are: The answer is correct but the formula written is incomplete. The results of the written test for subject C2 for number 4 are: The correct answer and the formula used are written in full. The results of time triangulation and data analysis of symbolic representation ability are, Subject D1 and Subject D2 are less capable of understanding the given problem well, presenting information from the given question, answering questions correctly and writing down the probability equation formula but do not provide a description of the symbol in the formula they wrote.

Kinestetic Learning Style Subjects

Subject D1 and Subject D2 are subjects who has been given a learning style test and a written mathematical representation test. Subject D1 is determined based on the results of the learning style test that has been given. Subject D1 gets the highest score in the kinesthetic learning style. The following are the results of Subject D1's mathematical representation ability test answers:

Word Representation Ability

The results of the written test for subject D1 for number 1 are: The correct answer and the reason given are also appropriate. The results of the written test for subject D2 for number 1 are: The answer is correct but gives a less clear explanation. The results of time triangulation and data analysis of the word representation ability are, Subject D1 and Subject D2 are quite able to understand the given problem and only answer some of the possible chance events correctly. Subject D1 and Subject D2 can determine some chance events and explain the reasons in words correctly.

Visual Representation Ability

The results of the written test for subject D1 for number 2 are: The method and formula used are correct and the right answer. The results of the written test for subject D2 for number 2 are: The method and formula used are correct and the right answer. The results of time triangulation and data analysis of visual representation ability are Subject D1 and Subject D2 are quite capable of understanding the given chance event problems. Subject D1 and Subject D2 present some information from the problem picture and then solve the given problem from the information obtained in the picture.

Image Representation Ability

The results of the written test for subject D1 for number 3 are: Fully drawn graphs and correct answer formulas. The results of the written test for subject D2 for number 3 are: The graph is drawn completely but the formula and answer are not right. The results

of time triangulation and data analysis of the ability to represent images are that Subject D1 and Subject D2 are quite capable of understanding the given problem well and can present a good tree diagram image from the information provided in the question. Subject D1 and Subject D2 present a complete tree diagram image and provide the number of sample spaces from the image they made.

Symbolic Representation Ability

The results of the written test for subject D1 for number 4 are: The correct answer and the formula used are written in full. The results of the written test for subject D2 for number 4 are: The answers are incorrect and the data information from the questions is also inaccurate. The results of time triangulation and data analysis of symbolic representation ability are, Subject D1 and Subject D2 are less capable of understanding the given problem well, presenting information from the given question, answering questions correctly and writing down the probability equation formula but do not provide a description of the symbol in the formula they wrote.

▪ CONCLUSION

The findings of the research and discussion reveal variations in mathematical representation skills across different learning styles. Students with a visual learning style demonstrate moderate ability in solving problems with verbal explanations but show limited skill in solving probability problems when relying on visual information. They excel in presenting mathematical representations through images to address problems and are proficient in determining probabilities by writing equations or formulas and performing calculations based on the given questions. Students with an auditory learning style exhibit moderate proficiency in solving problems with verbal explanations and show strong capability in solving probability problems using visual information. They are skilled in presenting mathematical representations in the form of images to solve problems and demonstrate moderate ability in determining probabilities by writing equations or formulas and performing the necessary calculations. Students with a read/write learning style show limited ability in solving problems with verbal explanations but are proficient in solving probability problems using visual information. They demonstrate moderate skill in presenting mathematical representations through images and determining probabilities by writing equations or formulas and performing calculations based on the given questions. Students with a kinesthetic learning style demonstrate moderate ability in solving problems with verbal explanations and in solving probability problems using visual information. They have moderate proficiency in presenting mathematical representations through images but show limited skill in determining probabilities by writing equations or formulas and performing calculations.

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