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Students' Mathematical Logical Thinking in Terms of Learning Style

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Abstract- One of the mathematical abilities that students must have been the ability to think logically. Students' mathematical logical thinking skills are still at a low level, resulting in students having difficulty learning the material given at school, especially straight-line equation material so in solving problems, various mistakes were found by students. This study aims to describe students' logical thinking skills in solving straight-line equation problems based on logical thinking skills and to describe students' learning styles with a thematic approach. This research is a descriptive study with a qualitative approach. This research was conducted randomly with the research subjects of class VIII as many as 20 students filling out the questionnaire and 4 subjects who took the logical thinking ability test, which consists of one student with high logical thinking skills, one student with moderate logical thinking skills, one student with thinking skills. low logical thinking, and one student with very low logical thinking skills. The data collection procedure in this study was a description test and a questionnaire to see students' learning styles. The results showed that the average logical thinking ability of students was 61.9 in the low category and the presentation of student learning styles was 10.8% visual, verbal 11.2%, aural 10.95%, physical 9.4%, logical 10.6. %, social 12.5%, and solitary 10.2%. This research can be carried out by the teacher to determine the students' logical thinking ability in solving the questions they give and can see the student's learning style so that the material presented is well received by students.

1. Introduction

Andriawan (2014) states that learning mathematics is a mental activity to understand the meaning, relationships, and symbols contained in mathematics systematically, carefully, and precisely, then apply the resulting concepts. To solve problems in everyday life. Rakhmawan & Vitasari (2016) revealed that learning mathematics is a process of interaction between teachers and students which involves developing a mindset that recognizes logic. Meanwhile, Fitriyah, et al (2019) revealed that mathematics is a lesson that can teach students to gain knowledge systematically or how to solve a mathematical problem. From the description above it can be concluded that learning mathematics is a process or activity that is structured to create services for the abilities, potential, interests, talents, and needs of students.

Solving problems is closely related to a mindset that knows logic. Sumarmo, et al (2012) stated that logic is the science of thinking in solving mathematical problems. Widyastuti & Pujiastuti (2014) state that logical thinking can be interpreted as a student's ability to draw conclusions according to the rules of logic and can prove that conclusion is valid (valid) following previously known knowledge. Meanwhile, Fitriyah, et al (2019) states that the ability to think logically needs to be developed in students' mathematics learning, because it can increase the progress of understanding mathematics.

Thinking and logic are a unity that is owned by humans to produce an idea or idea that they need. Andriawan (2014) reveals that logical thinking is a way of thinking that is coherent, reasonable, and based on the facts of certain objects. Logical thinking can also be interpreted as a student's ability to draw valid conclusions according to the rules of logic and can prove that conclusion is true (valid) following previously known knowledge (Purwanto, 2012). The ability to think logically in mathematics is synonymous with mathematical reasoning (Nugraha & Mahmudi, 2015). Mathematical reasoning is part of mathematical thinking which includes the formation of valid generalizations and conclusions,

Inductive Thinking.

Nugraha & Mahmudi (2015) state that inductive thinking is defined as a thought process to draw general conclusions from specific matters. In mathematics, particulars are several premises. The process of inductive thinking begins with drawing special circumstances from several premises to obtain a perception of patterns or regularities and similarities so that a conclusion is obtained. Wicaksono, et al (2012) revealed that inductive thinking is the ability to think processes that start from special circumstances to general circumstances. Based on the description above, inductive thinking is a thinking process to conclude in the form of principles or attitudes that apply specifically based on general facts.

Consider the following examples of inductive thinking.

1. Known lines with equations $y = 6x$ through the centre coordinates.
2. Lines with equations through the centre point of the coordinates $y = 7x$.
3. Thus, the line with the equation for a real number passes through the centre of the coordinates $y = mxm$

Deductive Thinking

Nugraha & Mahmudi (2015) state that deductive thinking is defined as a process of drawing conclusions that go from general principles to specific matters. Meanwhile, Wicaksono, et al (2012), revealed that deductive thinking is a thinking process ability that starts from general statements and draws specific conclusions. Based on the above opinion, it can be concluded that deductive thinking is a thought process to conclude from general statements to specific statements.

Consider the following example.

1. All lines with equations $y = mx$ through the centre coordinates.
2. The lines have the equation $ly = mx$.
3. Then, the line through the centre point of the coordinates $y = 4x$.

It can be concluded that logical thinking has the keywords pattern recognition and conclusion. So logical thinking can be defined as the process of concluding utilizing inductive thinking and deductive thinking which is limited to inductive generalizations, inductive analogies, conditionals (modus components and tolens), and syllogisms (hypotheticals and quantification). Nugraha & Mahmudi (2015), stated that logical thinking has four indicators namely.

1. Determine the similarity of relationships in a pattern of pictures or numbers.
2. Draw general conclusions from a pattern of pictures or numbers.
3. Concluding from the premises in the form of modus ponens and tokens.
4. Conclude from hypothetical and quantitative premises.

Based on preliminary observations that have been made at one of the Public Middle Schools in Cirebon City, in general, class VIII students have a poor response to the material presented by the teacher, due to the lack of readiness of students in dealing with learning material, students can only memorize and recall information. given, they are not able to analyze and develop the information provided by the teacher. One math teacher said that "the level of ability of students in receiving the information provided is different. Some students can write down known information and provide reasons for facts or relevant evidence at each step in making decisions or drawing conclusions from the information obtained. Likewise, when students are given tests or questions,

One of the factors that influence the high and low ability of students is the learning style of Papilaya & Huliselan (2016). Hilmi & Ghufron (2017) revealed that a learning style is an approach that explains how individuals learn or the ways each person takes to concentrate on the process, and master's difficult information through different perceptions. A person's learning style is a combination of how a person absorbs, organizes, and manages the information obtained (DePoter & Hernacki, 2010). Learning style is the easiest way for individuals to absorb, organize, and process the information received, an appropriate learning style is key to student success in learning (Bire, et al, 2014).

Based on the memletics approach there are seven types of learning styles namely, visual or spatial (prefers to use pictures, pictures, and spatial understanding), aural or auditory-musical (prefers to use sound and music), verbal or linguistic (prefers to use words, both in speech and writing), physical or kinesthetic (prefers to use the body, hands, and senses of touch, logical or mathematical (prefers to use logic, reasoning, and systems), social or interpersonal (prefers to learn in groups or with other people), solitary or intrapersonal (preferring to work alone and using independent learning) Referring to previous research conducted by Kurniawan (2015) regarding learning styles with a memletic approach to elementary school students using quantitative methods.

Visual learning style (spatial) students prefer to use pictures and spatial understanding. Amin (2016) revealed that the visual learning style is that they learn something best through sight, visual learning has difficulty absorbing information through verbal presentations without pictures. Students who have a visual learning style learn by focusing on sight (Suid & Yusuf, 2016). That is, concrete evidence must be shown first so that they understand, this learning style relies on sight or seeing the evidence first so that they can believe it. The characteristics of students who have a visual learning style are a high need to see and capture information visually before students understand it. Students who have a visual learning style capture lessons through pictorial material. In addition, it has a strong sensitivity to colour. In simple terms, the teacher can adjust the way of teaching to the visual student learning style including, using symbols, providing concepts to students, encouraging students to provide their concepts using symbols or colours, and using colourful images, graphs, or tables as learning media.

Aural (auditory-musical) students prefer to use sound or music. Rijal & Bachtiar (2015) revealed that the auditory learning style can absorb information through hearing. The auditory learning style is learning by relying on hearing to be able to understand and remember (Yusuf, 2016). Their auditory learning style learns through hearing (Amin, 2016). That is, students with an auditory learning style absorb information by hearing, they generally have difficulty absorbing information in written form. The characteristics of students with an auditory learning style include being easily distracted by noise, moving their lips to read aloud, and finding it difficult to write, but great at telling stories. In simple terms, the teacher can adjust the way of teaching with the auditory learning style including,

Verbal (linguistic) students prefer to use words, both in speech and in writing. Lu & Yang (2018) reveal that the verbal learning style is imparting information obtained by focusing on explanations with written or spoken sentences. Kurniawan (2017) Individuals with a verbal learning style like to play with words. From the description above it can be concluded that students who have a verbal learning style are comfortable with reading, speaking, and writing a lot while studying. The characteristics of students with verbal learning styles tend to like word games, poetry, and rhymes, to find the meaning of words.

Physical (kinesthetic) students prefer to use the body, hands, and sense of touch. Rijal & Bachtiar (2015) revealed that the kinesthetic learning style requires the individual concerned to touch something that provides certain information to remember it. The kinesthetic learning style is a learning style in which learning is carried out physically (Yusuf, 2016). From the description above it can be concluded that the kinesthetic learning style is a learning style by moving the body so that it can be remembered. Its

characteristics are speaking through limb movements, and giving many responses when learning demonstrations.

Logical (mathematics) students prefer to use logic, reasoning, and systems. Kurniawan (2017) states that someone with a logical learning style will prefer activities that involve the brain, usually, students will quickly become aware of a pattern, and see the connection between one piece of information with other information that many people usually don't realize. Students can also understand something by connecting connections from various details and arranging them in an organized manner, such as by playing a puzzle (Kurniawan, 2015). From the description above, students who have a logical learning style prefer lessons that are problem-solving skills, systematic, and do not need to rely on memorization.

social(interpersonal) students prefer to study in groups or with other people. Kurniawan (2017) states that someone with a strong social learning style will very easily communicate with other people verbally and non-verbally. Kurniawan (2015) states that students' interpersonal learning styles have good social skills such as communicating verbally and in writing. From the description above, it can be concluded that students who have a social learning style will be more comfortable consulting and discussing lessons with teachers and classmates, and like learning by expressing ideas and discussing the related subject matter.

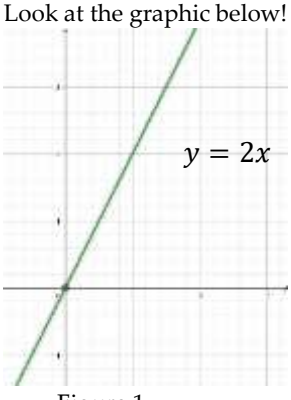
Solitary(intrapersonal) students prefer to work alone and use self-study. Kurniawan (2017) states that someone with the solitary type is a more private or independent individual. Students like to study in quiet and solitude. Kurniawan (2015) stated that students tend to have an intrapersonal learning style by doing everything themselves, students can make and know personal interests and goals. From the description above, it can be concluded that students who have a solitary learning style prefer to read books or learn from laptops or cell phones.

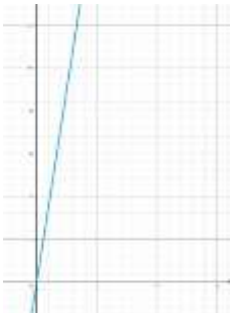
Based on the description above, the researcher is interested in analyzing the ability to think logically in terms of learning style. This study aims to measure students' logical thinking skills as seen from the way students' learning styles. In addition, this research is important for students, to find out students logical thinking skills in the material of straight-line equations.

2. Methods

This type of research is a type of descriptive qualitative research. Subjects with class VIII who have studied straight-line equations material. With a subject of 20 students to fill out a questionnaire and a subject of 4 students to fill out a description test, which consisted of one student with high logical thinking ability, one student with medium logical thinking ability, one student with low logical thinking ability, one student with moderate logical thinking ability, and one very low logical thinking. The instrument in this study used description questions using indicators of logical thinking ability from Nugraha & Mahmud (2015) and learning styles using indicators from memletics.

Table 1. Problems and Indicators Logical Thinking

No.	Problems	Indicators Logical Thinking
1.	Look at the graphic below!  Figure 1.  Figure 2.	Determine the similarity of relationships in a relationship pattern or image.

No.	Problems	Indicators Logical Thinking
	$y = 7x$  Is there a similar relationship between picture 1, picture 2, and picture 3, if yes, state anything! Can you deduce the general form of the equation of the line? Figure 3.	
2.	Pay attention to the statement below.  It is known that the line with the equation $y = 6x$ passes through the center point of the coordinates.  Lines with equations $y = 9x$ through the center point. Make a general conclusion from the statement above!	Draw general conclusions from a drawing pattern.
3.	Pay attention to the following statement! a. If the line h has the equation of the form $y = x$ then the line l goes up. b. If the line l has the equation of the line $y = 4x$. So... From the statement above, conclude! Can you deduce the general form of the equation of the line?	Concluding from premises in the form of modus ponens.
4.	Pay attention to the following statement! a. If the line k does not have an equation of the form $y = x$ then the line k does not increase. b. If the line k goes up. So... From the statement above, conclude!	Concluding from premises in the form of modus tolens.
5.	Pay attention to the following statement! a. Some of the lines through O (0,0) have the equation of the line $y = mx$. b. Some lines have the equation $y = mx + 1$. So... Conclude the statement above!	Conclude from premises in quantitative form.

No.	Problems	Indicators Logical Thinking
6.	Pay attention to the following statement! a. If two straight lines are parallel, their gradients will be the same. b. There are two perpendicular lines. So... Conclude the statement above!	Conclude from hypothetical premises.

Table 1 shows examples of logical thinking questions on competency: a) analyze linear functions (as straight-line equations) and interpret their graphs concerning contextual problems; b) solve contextual problems related to linear functions as straight-line equations.

Kurniawan (2015) breaks down memletics learning styles as follows in Table 2.

Table 2. Indicators Learning Style

No	Indicators	Meaning	Statement
1	Visual (spatial)	Students prefer to use pictures, images, and spatial understanding.	1,2,6,10,12,13, 20,27,29,32
2	Aural (auditory-musical)	Students prefer to use sound and music.	17,18,33,34,38, 39,40,41,42,43
3	Verbal (linguistics)	Students prefer to use words, both in speech and writing.	3,14,15,16,26, 35,36,37,68,69
4	Physical (kinesthetic)	Students prefer to use the body, hands and sense of touch.	19,21,22,23,24, 44,45,46,47,49
5	Logical (mathematics)	Students prefer to use logic, reasoning and systems.	5,7,11,50,52, 53,54,55,56,57
6	Social (interpersonal)	Students prefer to study in groups or with other people.	4,8,25,28,59, 60,61,62,67,70
7	Solitary (intrapersonal):	Students prefer to work alone and study independently.	9,28,30,31,48, 51,63,64,65,66

Visually, the memletics learning style can be shown in Figure 1.

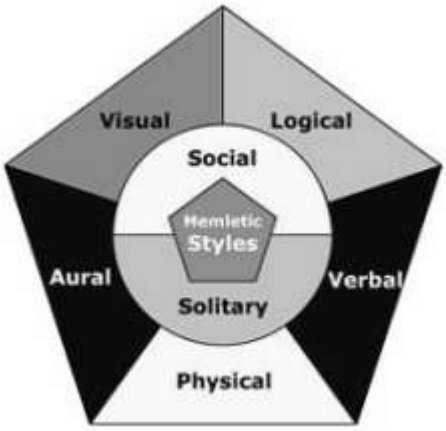


Figure 1. Memletics Learning styles

Table 2 and Figure 1 show that learning styles are divided into eight learning styles. Each learning style indicator is measured by the same number of statements, namely ten statements each.

3. Results and Discussion

The results of the research show that the student's learning styles are as follows.

Table 3. Student Learning Style

Learning Style	Visual	Verbal	Aural	Physical	Logical	Social	Solitary
Total	216	224	219	188	212	250	204
Percentage	10.8	11.2	10.95	9.4	10.6	12.5	10.2

From Table 3, 20 subjects fill out a learning style questionnaire with different learning styles, there is 1 subject with a visual learning style, 2 subjects with a verbal learning style, 3 subjects with aural or auditory learning styles, and 2 subjects with a physical or learning style. kinesthetic, 1 subject with a logical learning style, 8 subjects with a social learning style, and 3 subjects with a solitary learning style. From the description above it can be concluded that the most dominant learning style of the 20 subjects is the social learning style or prefer to study in groups. Based on previous research conducted by Kurniawan (2015) the results of the dominant learning style are visual learning styles with a representation of 58.6.

Table 4. Logical Thinking Ability Test Scores

No	Name	Score	Category
1	SS	57.5	Low
2	SR	40	Very Low
3	CAO	72.5	Currently
4	K	80	Tall

Table 4 shows that SS subjects got a score of 57.5 on the low-category logical thinking ability test and SS subjects were more dominant in liking aural or auditory learning styles. Yusuf (2016) auditory learning style is a learning style that relies on hearing to be able to understand and remember. So that in this study the SS subject could not complete the test questions properly because in the test there were no questions in the form of audio, Yusuf's opinion regarding the auditory learning style matched the results of the SS subject's logical thinking ability test. The characteristics of students with an auditory learning style include being easily distracted by noise, moving their lips to read aloud, and finding it difficult to write, but great at telling stories. In the logical thinking ability test, the SS subject at point A can write down the similarity of the relationship from an image, but at point b cannot write down what is known and asked in the problem.

SR subjects in Table 4 get a score of 40 on the logical thinking ability test with a very low category and SR subjects are more dominant in social learning styles. Kurniawan (2017) states that someone who has a strong social learning style will very easily communicate with other people and this type will prefer to study in groups. So that in this study the SR subjects could not complete the test questions properly because in working on the test questions individually following their respective abilities they were not allowed to work together with other students, Kurniawan's opinion regarding social learning styles was right with the results of the subject's logical thinking ability test SRs are right. The characteristics of students with a social learning style include students, who will be more comfortable consulting and discussing lessons with teachers and classmates, and like learning by expressing ideas and discussing the related subject matter. In the test of the ability to think logically subject SRsubject could not solve the problem correctly. At this point, the subject cannot write down the similarity of the relationship between the 3 pictures in the problem. For point b the subject cannot write down what is known and asked in the problem and cannot solve the equation of the line. And point c, the subject can conclude the general form of the three images in the problem.

CAO subjects in Table 4 get a score of 72.5 on the logical thinking ability test in the medium category and CAO subjects are more dominant in liking physical or kinesthetic learning styles. Rijal (2015) reveals that the kinesthetic learning style requires the individual concerned to touch something that provides certain information to remember it. So that in this study the CAO subjects could not complete the test questions properly. As forIts characteristics are speaking through limb movements, and giving lots of responses when learning demonstrations, because the logical thinking ability test only works on questions and does not present the results of student answers. then Kurniawan's opinion regarding the social learning style is right with the results of the SS subject's logical thinking ability test right.

Subject K in Table 4 gets a score of 80 on the logical thinking ability test with a high category and subject K prefers a visual learning style more dominantly. Amin (2016) revealed that the visual learning style is

that they learn something best through sight, visual learning has difficulty absorbing information through verbal presentations without pictures. So that in this study subject K can complete the test questions well. On the logical thinking ability test, subject K can solve straight-line equations. At a point, the subject can write down the similarity of the relationship from an image in the problem. For point b, the subject writes down what is known and asked in the problem and can solve the equation of the line correctly. And point c, the subject can conclude the general form of the three images in the problem. The characteristics of students who have a visual learning style are a high need to see and capture information visually before students understand it. Students who have a visual learning style capture lessons through pictorial material, then Kurniawan's opinion regarding the verbal learning style is right with the results of the test of the logical thinking ability of subject K is right.

4. Conclusion

Students' logical thinking skills are in a low category with an average score of 61.9. Each student likes a different learning style, which can be seen from the results of the student's work on the test of their logical thinking ability. Presentation of student learning styles is visual 10.8%, verbal 11.2%, aural 10.95%, physical 9.4%, logical 10.6%, social 12.5%, and solitary 10.2%. The most dominant learning style favoured by students is the social learning style. These results are different from previous research conducted by Papilaya & Huliselan (2016), with the results of the study that most students tended towards an auditory learning style with 20 students with a presentation of 51.3%.

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