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Students' Mathematical Literacy Ability from van Hiele's Theory in Geometry

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Abstract: Mathematical literacy in Indonesia in 2015 saw the results of the Pisa show that it was ranked 62 out of 70 countries by obtaining a score of 386. That the mathematical literacy of Indonesian students is not satisfactory or can be said to be low. The method used in this research is qualitative research. The purpose of this study was to describe students' mathematical abilities in terms of Van Hiele's theory. Data collection techniques include (1) test questions, (2) interviews, and (3) documentation. Data supporting data analysis used includes data reduction, data presentation, and drawing conclusions. The results obtained were that students with level 3 at Van Hiele were included in the high level category at the junior high school level able to complete 6 indicators of mathematical literacy well, which means students with level 3 Van Hiele then mathematical literacy would be high. Students with level 1 on moderate Van Hiele are only able to complete 4 indicators of mathematical literacy well because students are only able to design strategies but are still lacking in using mathematical tools, while students with level 0 on low Van Hiele are only able to complete 2 indicators of mathematical literacy well because students are less able to design strategies because in the process students are still hesitant in solving a problem.

Keywords: mathematical literacy, van Hiele theory, junior high school students.

Abstrak: *Literasi matematis di negara indonesia pada tahun 2015 melihat hasil pisa menunjukkan pencapaian menduduki peringkat ke 62 dari 70 negara dengan memperoleh skor sebanyak 386. Bahwa literasi matematika peserta didik indonesesia belum memuaskan atau bisa dikatakan rendah. Metode yang digunakan pada penelitian ini adalah penelitian kualitatif. Tujuan dari penelitian ini adalah untuk mendeskripsikan kemampuan matematis siswa ditinjau dari teori Van Hiele. Teknik pengumpulan data meliputi (1) Soal Tes, (2) wawancara, dan (3) dokumentasi. Data pendukung analisis data yang digunakan meliputi reduksi data, penyajian data, dan penarikan kesimpulan. Hasil yang didapat bawah siswa dengan level 3 pada Van Hiele termasuk kategori level tinggi pada tingkat smp mampu menyelesaikan 6 indikator literasi matematis dengan baik yang artinya siswa dengan level 3 Van Hiele maka literasi matematis akan tinggi. Siswa dengan level 1 pada Van Hiele sedang hanya mampu menyelesaikan 4 indikator literasi matematis dengan baik karena siswa hanya mampu sampai merancang strategi tapi dalam penggunakan alat matematika masih kurang, sedangkan siswa dengan level 0 pada Van Hiele rendah hanya mampu menyelesaikan 2 indikator literasi matematis dengan baik karena siswa kurang mampu dalam merancang strategi karena dalam pengerjaan siswa masih ragu-ragu dalam menyelesaikan suatu soal.*

Kata kunci: *literasi matematis, teori van Hiele, siswa SMP.*

▪ INTRODUCTION

The development of the times in the industrial era is now experiencing a very rapid revolution, especially in the world of education. Changes are seen in the world of education which is entering the era of the industrial revolution 4.0 in line with the explanation from (Kemristekdikti, 2018), that the fourth world industrial revolution in which information technology has become the basis of human life. The world of

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education in Indonesia is currently in a learning recovery period, one of the ongoing learning during the recovery period is learning mathematics.

Learning mathematics is one that plays an important role in shaping the mindset of students by developing abilities between logical, systematic thinking, analysis, and the ability to know mathematical literacy. Mathematical literacy is the minimum ability possessed by someone in the field of mathematics that can be used to survive in facing tasks in the area of expertise (Abidin, 2018). That mathematical literacy can be defined not only in advanced mathematics for solving a problem in learning such as algebra, calculus or analysis, but in understanding a problem to solve it in the form of interpretation. The world of education knows about the branches of mathematics, in general there are 4 branches namely arithmetic, algebra, geometry, and analysis. Among the various branches of mathematics, geometry is the science that touches almost all aspects of our lives. Geometry, which is a branch of mathematics, has an important role to learn. The importance of learning geometry for students is to open up more opportunities for students to explore, observe, and discover at each learning level, especially if there are activities and assignments that make their mathematical abilities visible.

Certain cases require special skills in implementing plans in solving problems (Baiduri, 2019). As with geometric problems, students' geometry skills can influence the success of implementing plans. Students' abilities can be seen from the process of thinking and applying skills in solving geometric problems. The application of Van Hiele's theory is believed to be able to overcome students' learning difficulties in geometry. This theory explains the development of students' thinking in learning geometry. In this theory, they argue that in studying geometry students experience the development of thinking skills through certain stages. Identifying these five stages in a concept level (levels) where students move sequentially in the journey of geometric thinking, According to Bobango 1993 (in Abdusakir: 2010) The five levels of development of thinking in van Hiele's geometry learning are level 0 (visualization), level 1 (analysis), level 2 (informal deduction), level 3 (deduction) and level 4 (rigor). Several researchers conducted, showed that students in junior high schools (SMP) only reached level 0-2 on Van Hiele's theory. Research conducted by Burger & Shaughnessy (1986) states that the thinking level of junior high school students in learning geometry is highest at level 2 (informal deduction) and most are at level 0 (visualization). This statement is also supported by the opinion of Van De Walle (2008) which states that most SMP/MTs students are in the stage between stage 0 (introduction) to stage 2 (sequencing).

Mathematical literacy is the minimum ability possessed by someone in the field of mathematics that can be used to survive in facing tasks in the area of expertise (Abidin, 2018). That mathematical literacy can be defined not only in advanced mathematics for solving a problem in learning such as algebra, calculus or analysis, but in understanding a problem to solve it in the form of interpretation. Mathematical literacy in conducting a preliminary analysis regarding the extent to which students understand the previous material. Based on the observations of students at SMP Negeri 4 Semarang that mathematical literacy in geometry material by looking at the Van Hiele level has been in a position below the average, it can be seen from the table below that the initial test was carried out. one of the materials studied by class VIII students is a flat shape. Flat

shape material is material that is difficult for students to understand, especially from the van Hiele level, the average class VIII junior high school student only gets to know what a shape is, without looking at the reason, they can know the name and characteristics of the shape.

This suspicion is reinforced by the results of the IMSTEP-JICA survey, that in learning mathematics, teachers concentrate too much on procedural and mechanistic matters, teacher-centered learning, mathematical concepts are conveyed in an informative manner, and students are trained to solve many problems without a deep understanding. In fact, this can hinder the learning process. As a result, the abilities, skills and competencies that students must have do not develop as they should. Hawa (2014) and Nurdianasari & Hartono (2015). In addition, according to Haji & Abdullah (2015), students will be more independent in learning mathematics so that it will increase their mathematical literacy. Based on this, the problem of how students' mathematical literacy is viewed from van Hiele's theory. Then a research was conducted with the aim of knowing the mathematical literacy of junior high school students in terms of Van Hiele's theory.

▪ METHOD

This type of research used is a qualitative research method. Qualitative research was used to analyze junior high school students' mathematical literacy based on Van Hiele's theory (Sukestiyarno, 2016). The qualitative research design uses case studies with the qualitative research approach used is grounded theory so that it allows the researcher to dig deeper into the problem under study, where the researcher conducts the initial stages of research in order to find problems in the field by conducting a study on the data, interviews with teachers, and studies on literacy. Grounded theory is a research strategy in which researchers generate general and abstract theories of certain processes, actions or interactions that come from the views of the participants (Creswell, 2016). This research was conducted at SMP Negeri 4 Semarang. The population in this study were all students of class VIII. In the research for selecting subjects using a purposive sampling technique, 3 students of class VIII B were selected based on their mathematical literacy abilities based on high, medium and low van hiele levels.

Data collection techniques were carried out using qualitative data collection techniques that would be used in research to find out the results of student literacy in terms of Van Hiele's theory, so the following data collection techniques were carried out (1) test methods (2) interviews and (3) documentation of results student work as a support. In this study using test instruments, after the research instruments were made then empirical trials were carried out to then analyze the validity and reliability of the tests as follows. In this study, the literacy ability test was reviewed by van Hiele, with the validity of each item being calculated using the Pearson Product Moment correlation formula. The test criteria are consulted with the product moment prices in the table with a significant level of 5%, if r_xy>r_tabel then the item is said to be valid. The following are the results of the test validation test questions

Table 2. Test item validation results

Question No.	r_{count}	r_{table}	Description
1	0.653	0.344	Valid
2	0.315	0.344	InValid

3	0.610	0.344	Valid
4	0.322	0.344	InValid
5	0.725	0.344	Valid
6	0.282	0.344	InValid

The results of the test item validation test showed that there were three valid questions and three invalid questions. So that can be continued for reliability testing. (Yusuf, 2017) Reliability is the stability or consistency of scores on an instrument for the same individual, and given at different times. The test reliability test criterion is after obtaining the price r_xy. The test criteria are consulted with the price r_table in the product moment table with a significant level of 5%, if r_xy>r_table then the item is said to be reliable. Based on the results of the test reliability calculation, it was obtained r_xy= 0.524, so it can be said that the items tested were reliable. This can be interpreted that the three questions can be used in research to analyze the results of students' mathematical literacy ability tests. Data analysis techniques mention data analysis in qualitative research including data reduction, data presentation, and drawing conclusions (Sugiyono, 2014). The data reduction stage begins with the selection of research subjects based on the results of the van Hiele level test and interviews with students' mathematical literacy. Furthermore, three students were selected based on Van Hiele's level. The next step after data reduction is data presentation. In qualitative research data presentation is usually done in the form of brief descriptions, charts, relationships between categories, flowcharts, and the like. In this case Miles and Huberman in Sugiyono (2014) stated that to present data in qualitative research is with narrative text.

In this study, data on students' mathematical literacy processes in terms of van Hiele's theory are presented in the form of tables, brief descriptions, and photos of student work based on indicators based on the OECD. Generating conclusions in qualitative research which are expected to be new findings that have never existed before. These findings can be in the form of a description or description of an object that was previously still dim so that upon examination it becomes clear. In this study, the conclusions in the form of a description of the abilities and processes of mathematical literacy were reviewed by van Hiele's theory of junior high school students.

▪ RESULT AND DISSCUSSION

The results and discussion were made based on research conducted in the experimental class, there were van hiele levels or levels and it was found that there were levels 2 (informal deduction), level 1 (analysis), level 0 (visualization) at the junior high school level. The following table divides the subjects based on Van Hiele's theory according to level.

Table 1. The van Hiele levels

No	Students Code	Levels 0		Levels 1		Levels 2		Levels 3		Levels
		Information		Information		Information		Information		
1	B-02	4	T	4	T	1	TT	2	TT	Levels 1
2	B-14	5	T	4	T	5	T	2	TT	Levels 2

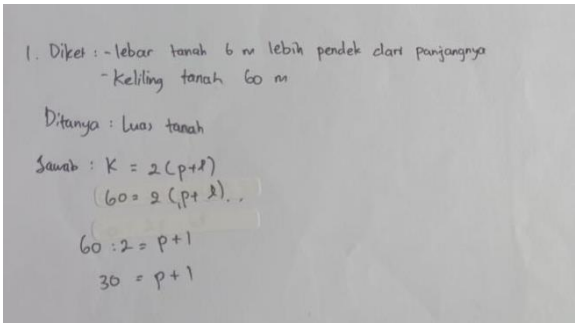
3	B-17	4	T	2	TT	2	TT	2	TT	Levels 0

Information:
B-17 = Subject of low mathematical literacy
B-02 = Medium mathematical literacy subject
B-14 = High mathematical literacy subject

Find out the process of mathematical literacy, 3 students were selected based on the results of the van Hiele level test. After that, they were given a written test of 3 questions about mathematical literacy. Then further analysis The grouping was divided into 3 subjects based on the Van Hiele level, each consisting of 1 subject level 0 (visualization), 1. subject level 1 (analysis), and 1 subject level 2 (informal deduction).

Description of B17 subject's mathematical literacy ability based on level 0 (Visualization)

Table 3. Results of subject B17's mathematical literacy test

Mathematical Literacy Indicator	Description
Communication *Mathematising* *Reasoning and argument* *Devising strategies for solving problems* *Using matematical tools* *Representation*	 Based on the answers of subject B17 on question no 1, then an analysis was carried out according to the Mathematical Literacy indicator with the following results. 1. Students can inform in written form. The results of the analysis of subject B17 show that students are able to communicate in written form what is known and asked in the questions based on the information obtained in question no 1. 2. Students are able to reason in solving problems. Subject B17 is less able to reason to find a solution but in writing the formula for the circumference of a flat shape is correct. 3. Design a strategy to solve the problem. Subect B17 in designing strategies is not quite right because the confusion in solving can be seen from the streaks on the paper.

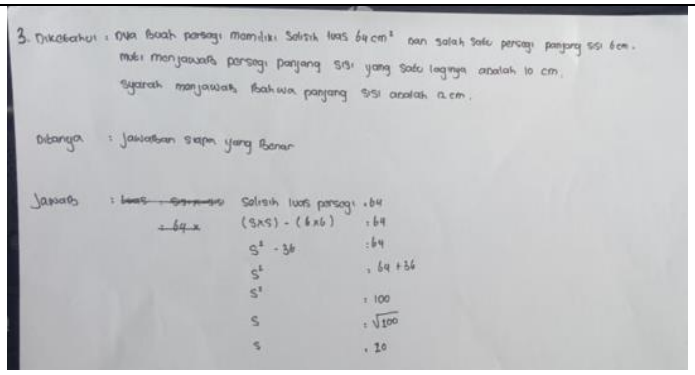
The results of the interviews showed that subject B17 was able to explain what was known in the questions and had difficulty finding answers to the problems in number 1. This can be seen from the results of improving the answers to question no 1.

In interviews, subject B17 was not precise in determining solutions. But subject B17 is able to explain the steps in solving problems such as explaining the formula for the perimeter of a rectangle. Based on the analysis of test results and the results of interviews with subject B17 on these questions, it can be concluded that subject B17 was only able to complete 1 indicator, namely communicating in written form. The triangulation results from the answers and interviews with subject B17 show that the two data are consistent and credible.

Description of B02 subject's mathematical literacy abilities based on level 1 (Analysis)

The results of the analysis of subject B02 were able to inform the problems in question number 3 but in solving the problems in question no 3 it was not right because it did not explain whose answer was correct. at number 1 in answering the problem is not quite right. Based on the results of the interviews, it was shown that subject B02 was able to explain smoothly what was known in the problem in finding answers to the problems in number 3. This can be seen from the results of the answers to question no. 3. In the interview, subject B02 was right in determining the solution. However, subject B02 did not write down whose answer was correct. In giving an answer, you need to be prompted first and then say the correct answer.

Table 4. Results of subject B02's mathematical literacy test

Mathematical Literacy Indicator	Description
Communication *Mathematising* *Reasoning and argument* *Devising strategies for solving problems* *Using matematical tools* *Representation*	 Based on the answers of subject B02 on question no 3, then an analysis was carried out according to the Mathematical Literacy indicator with the following results. 1. Students can inform in written form. The results of the analysis of subject B02 show that students are able to communicate in written form what is known and asked in the questions based on the information obtained in complete question no 3. 2. Design a strategy to solve the problem. Subject B02 is able to write the complete formula to find the solution in question number 3 which is incomplete. 3. Students are able to use mathematical tools to solve problems.

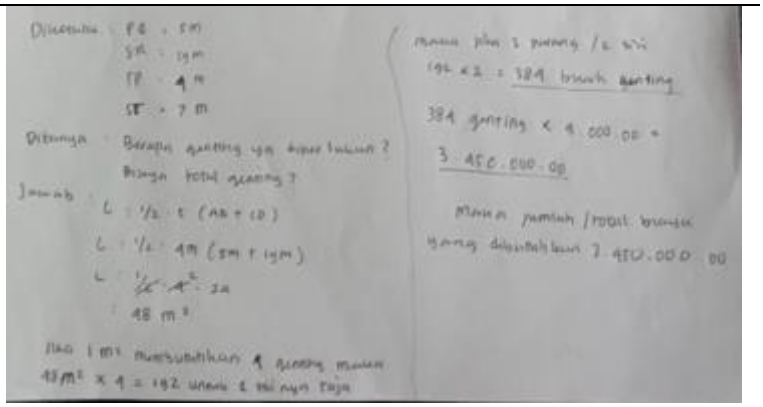
	Subject B02 is able to use mathematical tools in finding answers to problems contained in question no 3, 4. Re-check the results of the problem. Subject B02 did not write down whose answer was correct.

Based on the analysis of test results and the results of interviews with subject B02 on question number 3, it can be concluded that subject B02 was only able to complete 3 indicators, namely communicating in written form, formulating solutions, calculating with appropriate mathematical tools but not determining whose answer was correct. The triangulation results from the answers and interviews with subject B02 show that both data are consistent and credible.

Description of B14 subject's mathematical literacy abilities based on level 2 (Informal Deductive)

The results of the analysis of subject B14 are able to inform the problems in question number 2 can solve the problems in question number 2 which are correct because it explains whose answer is correct. This can be seen from the answers of subject B14 in writing the continuation of the flat shape formula in number 2 in answering the problem. that's right. Based on the results of interviews with subject B14, it was shown that subject B14 was able to explain smoothly what was known in the problem in finding answers to the problems in number 2. This can be seen from the results of the answers to question no 2. In interviews, subject B14 was right in determining solutions, writing formula well.

Table 5. Results of subject B14's mathematical literacy test

Mathematical Literacy Indicator	Description
Communication *Mathematising* *Reasoning and argument* *Devising strategies for solving problems* *Using matematical tools* *Representation*	 Based on the answers of subject B14 on question no 2, then an analysis was carried out according to the Mathematical Literacy indicator with the following results 1. Students can inform in written form. The results of the analysis of subject B14 show that students are able to communicate in written form what is known and asked in the questions based on the information obtained in complete question no 2. 2. Design a strategy to solve the problem.

	Subject B14 is able to write the complete formula to find the complete solution in question number 2. 3. Able to reason Subject B14 can reason from the answers that are written using the right formula and can make their own arguments. 4. Students are able to use mathematical tools to solve problems. Subject B14 is able to use mathematical tools in finding answers to problems contained in question no 2, 5. Re-check the results of the problem. Subject B14 is able to write down whose answer is correct.

Based on the analysis of test results and the results of interviews with subject B14 on question number 2, it can be concluded that subject B14 is able to complete 5 indicators, namely communicating in written form, formulating solutions, calculating with the right mathematical tools and being able to determine the answers correctly. The triangulation results from the answers and interviews with subject B14 show that both data are consistent and credible.

Based on the description of Van Hiele's mathematical literacy skills with level 0 (introduction), Subject B17 is able to explain what is known in the problem and has difficulty finding answers to problems only being able to complete 1 indicator, namely communicating in written form. Students at the Van Hiele level with level 1 (Analysis), subject B02 are able to complete 3 indicators, namely communicating in written form, formulating solutions, calculating with appropriate mathematical tools but not determining whose answer is correct and students with van Hiele level with level 2 (Deduction Informal), that subject B14 is able to complete 5 indicators, namely communicating in written form, formulating solutions, calculating with appropriate mathematical tools and being able to determine answers correctly, in completing steps of good mathematical literacy. Based on the results of interviews and the results of student work, it shows that level 2 students have better mathematical abilities than students with levels 0 and level 1. In line with research by Yulia, Martin, & Juli (2021) that students with high abilities can solve routine problems, interpret problems and solve them with formulas, carry out procedures well, can deal with complex situations, use their reasoning in solving problems, can work effectively and interpret different representations accordingly. Students with moderate abilities can solve routine problems, interpret problems and solve them with formulas, and carry out procedures correctly, while students with low abilities can only communicate based on what is known without solving them using procedures.

▪ CONCLUSION

Based on the mathematical literacy ability of subject B17 on the question, it can be concluded that subject B17 is only able to complete 1 indicator, namely communicating in written form, subject B02 the results of the answers in table 3 can be concluded that subject B02 is only able to complete 3 indicators, namely communicating in written form, formulate solutions, calculate with appropriate mathematical tools but do not determine whose answer is correct and subject B-14 on the answer sheet table 3 it can be concluded that subject B-14 is able to complete 5

indicators namely communicating in written form, formulating solutions, calculating with appropriate mathematical tools and can determine the correct answer.

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