UJMER 10 (1) (2021) 77 - 83

Unnes Journal of Mathematics Education Research

http://journal.unnes.ac.id/sju/index.php/ujmer

The Ability to Complete Story Problems Reviewed from Van Hiele's Theory in Problem Based Learning

Ono Sudarsono [1]✉, Awalya Awalya[2], Iwan Junaedi[2]

[1.] SDN 2 Pamulihan Kab. Kuningan, Jawa Barat, Indonesia
[2.] Universitas Negeri Semarang, Indonesia

Article Info

Article History:
Received :
10 January 2021
Accepted:
1 March 2021
Published:
30 June 2021

Keywords:
Geometry Story Questions, Van Hiele's Theory, Problem Based Learning

Abstract

The purpose of this study was to find the pattern of the ability to solve geometrical story questions for fourth grade students in terms of Van Hiele's theory in the problem-based learning model. The research method used was a mixed method. The research was conducted at SDN 2 Pamulihan Cirebon. The data collection techniques used were test techniques and non-test techniques. The analysis was carried out qualitatively. The results of the study were found as follows: (a) the ability of grade IV students in solving story questions is still at the level 1 or analysis level, the students have not yet reached the level of abstraction, formal deduction, and rigor, (b) the subject of the visualization level has a pattern to identify elements. -the element that is known, but cannot mention the element in question; unable to compile mathematical models, unable to plan solving problems; (c) the analysis level subject has a pattern that can identify the known and questionable elements; be able to compile a mathematical model even though it is incomplete, be able to plan solving the problem of the story problem correctly but not systematically; can state the formulas to be used to solve the problem correctly but not systematically can answer the problem of the story correctly but the arrangement is not yet systematics.

✉Correspondence:
Pamulihan, Cipicung, Kabupaten Kuningan, Jawa Barat, Indonesia
E-mail: onosudarsono115@gmail.com

p-ISSN 2252-6455
e-ISSN 2502-4507

INTRODUCTION

Mathematics is a lesson that is arranged in an orderly, logical manner, tiered from the easiest to the most complex. According to Russefendi (Murniati, 2003) states that mathematics is organized from undefined elements, definitions, axioms, and arguments, where the arguments after being verified are generally valid.

Data from the year 2 TIMSS four-year survey shows that the mathematics reading ability of Indonesian students of grade IV SD is 45th out of 50 countries (the International Association for the Evaluation of Educational Achievement) (EIA, 2015). This shows that the quality of mathematics learning in Indonesia is still very low.

Indonesian students master routine questions, simple computation, and measure knowledge of facts with daily contexts. Students need to strengthen the ability to integrate information, draw conclusions, and generalize their knowledge to other things, such as students' ability to solve story problems, the tendency of students to prefer to work on problems in the form of mathematical formulas compared to story problems which must combine the ability to integrate information, explore and draw conclusions in the form of mathematical notation.

To solve story problems, students must have problem-solving skills which is a part of math ability. According to Sternberg and Ben-Zeev (Kadir, 2010) problem solving is a cognitive process that opens up opportunities for problem solving to move from a state that is not known how to solve it to a situation but does not know how to solve it.

The material taught in grade IV on the subject of geometry is the circumference and area of a flat shape, where critical thinking and reasoning is needed with the ability to abstraction logically to its concepts. Geometry is a branch of mathematics that was born from the conditions of everyday life, geometry is an abstraction of the real world or a model that helps reason and logic. Van Hiele is an educational expert who pays attention to the level of student ability in learning geometry.

Based on the results of observations on the fourth grade students of SDN 1 Pamulihan and SDN 2 Pamulihan, it was found that students' understanding of geometry was still very low, students were more likely to memorize material rather than understanding concepts. In addition, it can be seen from the teaching factors or learning techniques used by the teacher, so that it does not attract students' interest in the teaching and learning process. In line with the results of preliminary observations (Rumiati, 2011) explain that 20% of Indonesian students can answer correctly one of the geometric problem solving problems regarding the concept of perimeter squares, rectangles and levels, it is recommended that the learning process in schools is more stressful.

With such conditions, choosing the right learning model will determine the level of ability and student learning outcomes. (Marwan, 2008) states that in the preparation of geometry learning materials, both the shape and content are expected to be in accordance with the cognitive development of students.

From the problems described above, this study takes the problem of the ability to solve geometry story questions for class IV in terms of Van Hiele's theory with a problem-based learning model.

According to (Mariani, 2018) the ability to solve math story problems is a person's ability to solve problems in the form of math story problems that are presented in the form of stories and are related to concrete things and are related to the daily life of students.

The ability to solve story problems shows the quality of learning. Where the operational quality of learning can be interpreted as the intensity of systemic and synergistic relationships between teachers, students, curriculum, and learning materials, media, facilities, and learning systems in producing optimal learning processes and outcomes in accordance with curricular demands (Depdiknas, 2004).

To find an overview of students' thought patterns, Van Hiele's theory is reviewed, namely the learning theory proposed by (Hiele, 1958), which describes the stages of children's mental development in geometry (1) Level 0. Visualization Level, (2) Level 1. Level Analysis, (3) Level 2. Abstraction Level, (4) Level 3. Formal Deduction Level, (5) Level 4. Rigor Level.

According to Van Hiele, all children learn geometry by going through these stages, in the same order, and it is not possible to skip levels. However, when a student starts to enter a new level is not always the same between one student and another. In addition, the process of development from one stage to the next is not primarily determined by age or biological maturity, but is more dependent on the teaching of the teacher and the learning process that students go through.

According to Boud and Felleti (Saptono, 2003) states that "Problem Based Learning is a way of constructing and teaching courses using problems as a stimulus and focus on student activity". (Barrows, 1982), as an expert on PBL, states that the definition of PBL is a learning method based on the principle that problems can be used as a starting point for acquiring or integrating new knowledge. PBL is a learning method that uses problems as a first step in gathering and integrating new knowledge (Suradijono, 2004).

The aim of the study was to find an illustration of the pattern of the ability to solve geometrical story problems for fourth grade students in terms of Van Hiele's theory in the Problem Based Learning Model learning.

METHOD

The approach used in this study is a mixed methods approach that uses a concurrent embedded strategy. (Creswell, 2009) explains that the embedded strategy is a mixed methods strategy that applies both quantitative and qualitative data collection stages at one time. The concurrent embedded strategy has a primary method as the main method and a secondary method as a supporting method. In this research, the quantitative method is the primary method, while the qualitative method is the secondary method. The research design used in quantitative research was a quasi experimental design using purposive sampling technique.

Table 1. Collection Techniques and Analysis Techniques

Collection Technique	Analysis Technique
Validation of Learning Tools	Based on Criteria
Ability Test to solve van Hiele's geometric story questions	Individual Completeness Test Classical Completeness Test 2 Sample Comparative Test
Interview Observation of Learning Implementation student work documents	Data Validation Data Reduksi Reduction Data Conclusion Withdrawal Triangulation

RESULTS AND DISCUSSIONS

The research subjects of the experimental class were all fourth grade students of SDN 2 Pamulihan, while the subjects of the control class were the control class students of SDN 1 Pamulihan.

Table 2. Preliminary Data Analysis

	Experiment	Control
Normality test	.200[c,d]	.200[c,d]
Homogeneity Test	.643	
Average Similarity Test	.462	

Based on the data above, the One-Sample Kolmogorov-Smirnov Test for the experimental class

and the control class are both 20%> 5%, then H0 is accepted. This shows that the initial data of students who will be taught with conventional learning models are normally distributed. And the initial data of students who will be taught with the PBL learning model in terms of Van Hiele's theory is normally distributed.

For Levene's Test for Equality of Variances, the significance value is 64.3%> 5%, then H0 is accepted. This shows that the initial data of students who will study with the PBL learning model are reviewed by Van Hiele's theory and students who will learn with homogeneous conventional learning.

And based on the t-test for equality of Means, the significance value is 46.2%> 5%, then H0 is accepted. This shows that the average initial data of students who will be taught with the PBL learning model in terms of Van Hiele's theory is the same as students with conventional learning.

Table 3. Quantitative Analysis of the Ability Test to Complete Story Questions

	Eksperiment	control
Normality test	.078[c]	.078[c]
Homogeneity Test	.561	
Average Difference Test	.001	

Based on the data above, the One-Sample Kolmogorov-Smirnov Test for the experimental class and the control class are both 7.8%> 5%, then H0 is accepted. This shows that the initial data of students who will be taught with conventional learning models are normally distributed. And the initial data of students who will be taught with the PBL learning model in terms of Van Hiele's theory is normally distributed.

For Levene's Test for Equality of Variances, the significance value is 56.1%> 5%, then H0 is accepted. This shows that the initial data of students who will study with the PBL learning model are reviewed by Van Hiele's theory and students who will learn with homogeneous conventional learning.

And based on the t-test for equality of Means, the significance value is 46.2%> 5%, so H1 is accepted. Therefore, it can be concluded that the ability to solve problems in the story problems of students taught with the PBL learning model in terms of Van Hiele's theory is higher than students who are taught with conventional learning models.

Data on the ability to solve story problems is the ability to solve story problems based on the steps of the pattern at each level of Van Hiele's geometric thinking, namely 1) understanding the problem is the student's ability to mention the information known in the story problem, mention the problem being asked, and make a sketch according to the information contained in the story problem, 2) planning is the student's ability to say the formula to be used and plan solving the story problems correctly and systematically, 3) executing the plan is the student's ability to answer story questions correctly and systematically because they can plan solving story problems correctly and complete, and write the final conclusion from the completion of the story questions 4) checking again is the ability of students to check again on the results of their work.

Table 4. TKMSC Results for each Van Hiele Thinking Level

Van Hiele's Level of Thinking	Total Students	KMSC average
Level 0	15 (53.57%	75.11
Level 1	13 (46.43%)	84.10
Total	28	79.29

Based on the data above, it can be seen that the students' scores in solving story problems are at level 0 and 1, which means that students have not been able to reach the higher Van Hiele thinking level, namely level 2 informal deduction, level 3 deduction, and level 4 rigor. According to (Mulyana Sumantri, 2011) states that children's cognitive development takes place regularly and sequentially according to their age development. Then teaching must be planned in such a way as to suit the development of students' intelligence.

In the step of understanding the problem, students in level 0 (visualization) can identify the elements that are known, but cannot mention the elements being asked. Level 0 students (visualization) are also unable to compile mathematical models, this can be seen from their inability to make sketches based on known elements. The results of this study are in line with the opinion of (Crowley, 1987) which states that students at level 0 (visualization) make

geometric shapes based on physical appearance as a whole. Therefore students at level 0 (visualization) cannot sketch geometric shapes only based on the description of the problem.

In planning step, students of level 0 (Visualization) cannot plan the problem solving correctly. Students at level 0 (visualization) also cannot mention the formulas used to solve story problem problems. This is because according to (D. Fuys., D. Geddes., 1988), the ability of students at level 0 (visualization) is still simply identifying the shape based on its appearance in its entirety, so that students at level 0 (visualization) have not yet determined the formula for solving problems in geometric story problems.

In the step of implementing the plan, students at level 0 (visualization) cannot answer the problem of the story correctly because they cannot plan the problem solving correctly. Therefore, it cannot write a final conclusion from solving the problem of the story problem. Students in level 0 (visualization) also cannot check the results.

In the step of understanding the problem, level I students (analysis) can identify the known and questionable elements. Level I students (analysis) can also compile a mathematical model even though it is not complete, this can be seen from the ability of level I students (analysis) to sketch geometric shapes but are not equipped with known elements.

The results of this study are in line with the opinion of (Crowley, 1987) which states that level I students (analysis) can identify and draw shapes that are given verbally or given their characteristics in writing. (Muhassanah Nur'aini, Iman Sujadi, 2014) also stated that students at level I (analysis) were able to construct images according to the characteristics given. So that students at level I (analysis) can sketch geometric shapes if the properties of these shapes are known.

In the step of planning, students at level I (analysis) can plan to solve the problem correctly but not systematically. Students at level I (analysis) can also mention the formulas used to solve the problem of the story correctly but not systematically.

In the step of implementing the plan, level I students (analysis) can answer the problem of the story question correctly but not systematically. Therefore it cannot write the final conclusion from solving the problem of the story problem. Level 1 students (analysis) also cannot check the results.

Discussion

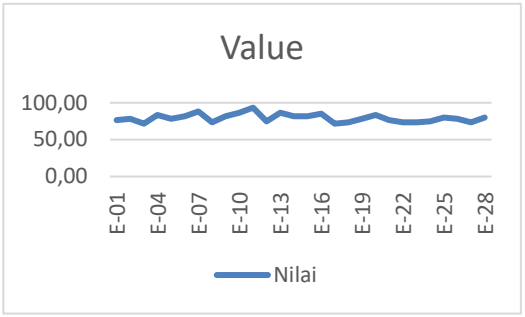

Figure 1. TKMSC Value Data for Experiment Class

Based on the data above, it can be seen that the average score for each student is above 70 which indicates that the Problem Based Learning model in terms of Van Hiele's theory is effectively used to solve story problems and support the development of mathematical problem solving abilities.

Some experts also state that problem based learning is effective in learning mathematics. (Maya Kurniawati, Iwan Junaedi, 2015) stated that problem based learning assisted by mathematical pop up book is effective for learning geometry. (Mareesh, 2013) who state that problem based learning is effectively applied to mathematics learning. (Oluwa, 2012) also states that problem based learning is effectively applied to mathematics learning.

In this study, the lowest Van Hiele geometry thinking level for fourth grade elementary school students was level 0 (visualization). Meanwhile, the highest Van Hiele geometric thinking level for grade IV elementary school students was level 1 (analysis). This is in line with several previous studies on students' geometric thinking levels. Among others, (Aisyah, 2007) states that the highest Van Hiele thinking level that can be achieved by elementary students is in the 3 initial stages of understanding geometry, namely level 2 (informal deduction). (Muhassanah Nur'aini, Iman Sujadi, 2014) state that the highest level of thinking Van Hiele that can be achieved by grade VIII junior high school (SMP) students is level 2 (informal deduction). (Shaughnessy, 1986) also stated that the thinking

level of junior high school students in learning geometry was the highest at level 2 (informal deduction) and most of it was at level 0 (visualization). This statement is supported by the opinion of (Van de Walle, 1994) which states that most junior high school students are between level 0 (visualization) to level 2 (informal deduction). (N. Khoiriyah, 2013) stated that the results of research on the thinking level of high school students based on Van Hiele's theory on three dimensional material in terms of cognitive style FD and FI consisted of level 0 (visualization), level 1 (analysis), and level 2 (informal deduction). This is in line with this study that students who are at level 2 (informal deduction), level 3 (formal deduction) and level 4 (rigor) for grade IV primary education have not been found.

CONCLUSION

Based on the results of this study, it is concluded that the ability to solve story problems for each level of geometric thinking in Problem Based Learning in terms of Van Hiele's theory is as follows. (a) the students' ability to solve story problems at level 0 (visualization) are as follows: 1) students can identify the elements that are known, but cannot mention the elements being asked; 2) students cannot compile mathematical models, this can be seen from their inability to make sketches based on what is already known; 3) students cannot plan to solve the story problems correctly; 4) students cannot mention the formulas used to solve story problems; 5) students cannot answer the problem of the story problem correctly because they cannot plan the problem solving of the story problem correctly; and 6) students also cannot check the results because they cannot solve the problem correctly. (b) The problem-solving abilities of students' story level I (analysis) are as follows; 1) students can identify the known and questionable elements; 2) students have been able to compile a mathematical model even though it is not complete, this can be seen from their ability to sketch geometric shapes but not yet equipped with known elements; 3) students can plan solving the problem of the story problem correctly but not systematically; 4) students can state the formulas to be used to solve problems correctly but not systematically; 5) students can answer the problem of the story correctly but the arrangement is not systematic; 6) students cannot write the final conclusion from solving the problem of the story problem; and 7) students also cannot check the results.

REFERENCES

Aisyah, N. (2007). Pengembangan Pembelajaran Matematika SD. Depdiknas.

Barrows, H. S. (1982). Problem Based Learning: A Research Perspective on Learning Interaction. Lawrence Erlbaum Associates. Inc. Publishing Industrial Aveneu. http://repository.upi.edu

Creswell, J. (2009). Research Design. Pustaka Belajar.

Crowley, M. L. (1987). The Van Hiele Model of the Development of Geometric Thought. National Council of Teachers of Mathematics.

D. Fuys., D. Geddes., R. T. (1988). The Van Hiele Model of Thinking in Geometry Among Adolescents. Journal for Research in Mathematics.

Depdiknas. (2004). Kurikulum dan Standar Isi Sekolah Dasar. Depdiknas.

EIA. (2015). Survey Internasional TIMSS. http://litbang.kemendikbud.go.id/index.php/survei-internasional-timss/tentang-timss

Hiele, V. (1958). Developing Geometric Thinking Through Activities that Begin with Play: Children Mathematics. http://abdussakir.wordpress.com./pembelajaran-geometri-dan-teori-van-hiele

Kadir. (2010). Penerapan Pembelajaran Kontektual Berbasis Potensi Pesisir Sebagai Upaya Peningkatan Kemampuan Pemecahan Masalah Matematis, Komunikasi Matematis, dan Keterampilan Sosial Siswa SMP. PPS Universitas Pendidikan Indonesia.

Mareesh, R. D. P. (2013). Effectiveness of Problem Based Learning in Mathematics. International Multidisciplinary E-Journal, III(I), ISSN: 2277-4262.

Mariani, A. (2018). Hubungan Kemampuan Membaca Pemahaman dengan Kemampuan Menyelesaikan Soal Cerita Matematika SD Kelas IV SDN Selebung Ketangga Tahun

Pelajaran 2017/2018. PPS FKIP Universitas Mataram. http://fkipunram.rf.gd/ifkip3.php%3Fnim%3DE1E014004

Marwan, M. I. (2008). Meningkatkan Kemampuan Siswa Sekolah Menengah Atas dalam Menyelesaikan Soal Matematika setara PISA melalui Pendekatan Konstruktivisme. Peluang, 1(2), 51–62. http://eprints.ums.ac.id

Maya Kurniawati, Iwan Junaedi, S. M. (2015). Analisis Karakteristik Berpikir Geometri dan Kemandirian Belajar dalam Pembelajaran Fase Van Hiele Berbantuan Geometers Sketchpad. ISSN: 2252. http://journal.unnes.ac.id

Muhassanah Nur'aini, Iman Sujadi, R. (2014). Analisis Keterampilan Geometri Siswa dalam Memecahkan Masalah Geometri Berdasarkan Tingkat Berpikir Van Hiele. ISSN, 2339–1685. http://jurnal.fkip.uns.ac.id

Mulyana Sumantri, N. S. (2011). Perkembangan Peserta Didik. Universitas Terbuka.

Murniati, N. A. N. (2003). Sistem Pengelolaan Pendidikan di Sekolah. IKIP PGRI.

N. Khoiriyah, et. Al. (2013). Analisis Tingkat Berpikir Siswa Berdasarkan Teori Van Hiele pada Materi Dimensi Tiga ditinjau dari Gaya Kognitif Field Dependent dan Field Independent. Pendidikan Matematika Solusi.

Oluwa, A. F. & S. (2012). Achievement in Cooperative Versus Individualistic Goal-Structured Junior Secondary School Mathematics Classroom in Nigeria. International Journal of Mathematics Trends and Technology, 3(3).

Rumiati, S. W. (2011). Instrumen Penilaian Hasil Belajar Matematika SMP Belajar dari PISA dan TIMSS. Kementrian Pendidikan Nasional, Badan Pengembangan Sumber Daya Manusia Pendidikan dan Penjaminan Mutu Pendidikan, Pusat Pengembangan Pemberdayaan Pendidik dan Tenaga Kependidikan (PPPPTK) Matematika.

Saptono, S. (2003). Strategi Belajar Mengajar Biologi. UNNES.

Shaughnessy, B. (1986). Characterizing the Van Hiele Levels of Development in Geometry. Journal for Research in Mathematics Education, 17(1), 31–48.

Suradijono, S. (2004). Problem Based Learning. Apa dan Bagaimana? Makalah Seminar Penumbuh Inovasi Sistem Pembelajaran Pendekatan Problem Based Learning Berbasis ICT.

Van de Walle, J. (1994). Elementary School Mathematics: Teaching Devolementally (2 nd Editi). Longmans.