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Description of Van Hiele's geometry thinking ability in solving open ended problems in the 7E-Learning Cycle in terms of self efficacy

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Abstract

Provision of geometry material carried out at several levels of education confirms that the burden of children's knowledge in receiving different geometry material is adjusted to the ability of children at each stage. This agrees with the theory of geometry thinking conveyed by Van Hiele. One of the constructivism learning models that is expected to be able to improve problem solving skills in students, including the 7E Learning Cycle model. The purpose of this study is (1) to describe the development of Van Hiele Geometry thinking skills in students in solving open ended problems in 7E Learning Cycle learning, and (2) describe the Van Hiele Geometry thinking skills of students in solving Open Ended problems in terms of Self Efficacy in learning 7E Learning Cycle. The population in this study were students of class IX Junior High School of 2 Kudus. Sampling was done by using purposive sampling technique, 6 subjects were selected, with 2 subjects for low self efficacy, 2 subjects for medium self efficacy and 2 high self efficacy subjects from class IX A as the experimental class.

1. Introduction

Mathematics as a scientific discipline is highly interconnected, the areas described in Figure 1 overlap and are integrated. The process of reasoning, proofing, problem solving, and representation is used in all areas of content.

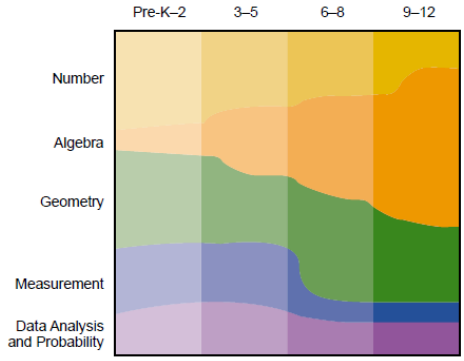

Figure 1. Standard Tables and Material Estimates

The Standards and estimates table in the figure highlights the estimated progress in the whole class. It is not recommended that each topic be discussed annually. The distribution of material according to NCTM especially in geometry material into several levels of education confirms that the burden of

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children's knowledge in receiving different geometry materials is adjusted to the ability of children at each stage. According to NCTM (2000) in the early years of schooling, students must develop visualization skills through direct experience with various geometric objects and through the use of technology that allows them to turn around, shrink, and experience changes in the shape of two and three-dimensional objects. This agrees with the theory of geometry thinking conveyed by Van Hiele, where the theory of geometry thinking begins with the introduction stage (visualization). Because learning geometry in schools needs to pay attention to the stages of Van Hiele geometry thinking.

According to some geometry experts describe relationships and reasoning. The idea of building geometric understanding throughout the class, from informal thinking to more formal, is consistent with the thinking of theorists and researchers (Burger and Shaughnessy 1986; Fuys, Geddes, and Tischler 1988; Senk 1989; Van Hiele 1986).

Liljedahl (2004) in Al-Absi (2012) presented a group of basic pre-service teachers a set of mathematical problems to solve. Some tasks enable mathematical discovery which he calls the discovery chain. According to Eric (2005) in Al-Absi (2012) Mathrex (Mathematics Reasoning Exercise) is a good way to involve students in learning mathematics enabling students to work in small groups to solve open ended problems, which provides opportunities to students to produce several solutions, and group discussions to make and justify decisions.

A study conducted by Black (2007) shows an increase in the ability to solve problems from an average of 71.4% to 77.2% after subjected to learning with the open-ended approach; students are given the opportunity freely to explore ways of solving problems that will used. Learners also have the opportunity to find various answers that fit the context of the problem.

There are various kinds of constructivism learning models that are expected to be able to improve problem-solving abilities in students, including the 7E Learning Cycle model. According to Simatupang (2008) in Darojat et al. (2016) Learning cycle is a learning model that is student-centered. The stages of learning activities are designed so that students can master a number of competencies that must be achieved through the role of student activities.

The stages in the 7E-Learning Cycle according to Eisenkraft (2003) in Wena (2009) there are seven stages consisting of Electricity, Engage, Explore, Explain, Elaborate, Evaluate, and Extend. The learning cycle model is one of the learning models in accordance with learning theory Piaget and other cognitive learning theories. This is because in the learning cycle involves three interactions, namely physical knowledge, social knowledge, and self regulation.

According to Bandura (1994) said that self-efficacy beliefs determine how people feel, think, motivate themselves and behave. Therefore, in addition to the ability to solve, self efficacy is also important in determining the success of achieving results. According to Schunk & Pajares (2010) in Sefiany et al. (2016), self efficacy affects academic motivation, learning, and achievement. High self-efficacy helps create a feeling of calm in the face of difficult tasks and activities. Conversely, people who doubt their abilities, they can believe that something is more difficult than it really is.

2. Methods

This research was conducted at Junior High School of 2 Kudus by involving students in three classes IX in the 2016/2017 academic year, namely classes IX A, IX B and IX E. Class IX E was chosen as a trial class. While class IX A as an experimental class treated with 7E Learning Cycle and class IX B as a control class treated with CPS learning methods.

Data collection techniques used in this research are self efficacy questionnaire, Van Hiele geometry thinking ability test, observation, interview, and documentation. The questionnaire is used to collect data about students' self efficacy. The interview method was conducted to obtain data directly about the Van Hiele geometry thinking skills of students in solving open ended problems in the essay questions on Van Hiele geometry thinking abilities.

Then with a purposive sampling technique (Sugiyono, 2015) selected research samples consisted of six students, namely two samples that have low self efficacy, two samples have medium self efficacy, and two samples that have high self efficacy. Following the results of the selection of research samples can be seen in Table 1. During the study period the six samples were observed during the learning activities and when doing the final test.

Table 1. Research Subjects

No.	Code	Classification
1.	E-01	Low self efficacy
2.	E-16	Low self efficacy
3.	E-05	Medium self efficacy
4.	E-28	Medium self efficacy
5.	E-22	High self efficacy
6.	E-17	High self efficacy

The study was conducted to obtain answers to the formulation of the problem in this study, namely how the development of Van Hiele's geometry thinking skills in open ended problem solving in learning 7E-Learning Cycle and how Van Hiele's geometry thinking skills of students in open ended problem solving in terms of self efficacy in learning 7E-Learning Cycle.

Data analysis in qualitative research was carried out since before entering the field, while in the field, and after completion in the field. But in reality, qualitative data analysis takes place during the data collection process (Sugiyono, 2015).

Triangulation technique is a data validity checking technique that utilizes something other than the data for checking purposes or as a comparison of that data (Moleong, 2011: 330). Triangulation in this study is to compare the results of Van Hiele's Geometry thinking ability test students in solving open ended problems with indicators of Van Hiele's Geometry thinking abilities and compare the results of Van Hiele's Geometry thinking ability test students with data from the Self Efficacy interview results.

3. Results & Discussions

The study was conducted in four meetings. Learning is carried out as many as three meetings and one meeting for the test at the end of learning. At the beginning of the meeting in the experimental class the self efficacy questionnaire was completed. At the end of the meeting, an essay thinking ability geometry test consists of 3 breakdown questions given to the experimental class and the control class. At the end of the study interviews were conducted on 6 samples related to the results of essay tests on the ability to think geometry.

The students 'essay test results were analyzed according to Van Hiele's geometrical thinking ability indicator in solving open ended problems in terms of students' self efficacy. Following is the analysis of subject data on Van Hiele's geometry thinking ability test results in solving congruence and congruence material problems.

3.1. E-01 Capability Analysis

E-01 subject's self-efficacy is categorized as low level. At the visualization stage, subject E-01 have been able to draw a figure even though the figure has not been given a name and can identify the figure with a complete appearance. However, the subject E-01 has not been neatly drawn.

In the analysis phase, subject E-01 is able to identify relationships between parts of a building, interpret brief verbal descriptions of shapes, be able to say forms of shapes based on certain traits. However, subject E-01 has not been able to solve geometry problems by using known wake properties. So for Van Hiele's geometry thinking abilities are categorized at the analysis stage.

3.2. E-16 Capability Analysis

The E-16 subject's self-efficacy is in the low self efficacy category. The E-16 subject fulfilled only a few indicators of geometric thinking ability until the analysis stage. At the stage of visualization, the E-16 subject has been able to draw a figure even though the figure that has been given a flat shape has not been given a name and is a little less tidy. The E-16 subject can identify the shape by its full appearance.

In the analysis phase, subjects E-16 were able to identify relationships between parts of a shape, interpret verbal descriptions about shapes, say a form based on certain characteristics in a nutshell. However, subjects E-16 have not been able to solve geometry problems by using known building

properties. Therefore, Van Hiele's geometry thinking skills on E-16 subject are categorized in stages of analysis.

3.3. E-05 Capability Analysis

One sample of the study of the ability to think geometry in terms of self-efficacy level is the subject E-05. After being analyzed, at the visualization stage, subjects E-05 had been able to draw shapes even though there were less neat drawing shapes. The E-05 subject can identify the wake briefly with full appearance.

In the analysis phase, subject E-05 is able to identify the relationships between parts of a shape, interpret verbal descriptions about shapes, say forms based on certain traits briefly and still need to be trained again. However, subject E-05 has not been able to solve geometry problems by using the properties of the wake.

At the informal deduction stage, subject E-05 has fulfilled all indicators at informal deduction stage, although it needs to be developed at each indicator.

3.4. E-28 Capability Analysis

Subject E-28 are categorized at the medium level of self efficacy. Ability to thinking about geometry Van Hiele's subject E-28 at the visualization stage, the subject has been able to draw up neatly. The E-28 subject can identify the building briefly with its full appearance.

In The analysis phase, Subject E-28 is able to identify the relationship between parts of a building, interpreting verbal descriptions about the shape, say the shape of the shape based on certain properties even with a brief explanation. However, subject E-28 is able to solve geometry problems by using the properties of two-dimensional shapes. However, there are some steps that are sometimes not written on the answer sheet.

At the informal deduction stage, all indicators are met however, the subject E-28 needs to develop his ability at all indicators at the informal deduction stage.

3.5. E-22 Capability Analysis

One sample of the study of the ability to think geometry in terms of high-level self-efficacy, the subject E-22. At the visualization stage, subjects E-22 have been able to draw a figure and can identify a figure with a complete appearance.

In the analysis phase, subject E-22 is able to identify relationships between parts of a building, interpret verbal descriptions about shapes, say shapes based on certain properties and be able to solve geometry problems by using known building properties.

At the informal deduction stage, the two subjects have fulfilled all the indicators at the informal deduction stage even though there are some steps that are not written in full. The findings in the field, there is one indicator at the deduction stage that has been fulfilled by subject E-22, namely identifying different possible strategies for finding a solution. However, for the next two indicators not yet fulfilled, the Van Hiele's geometry thinking ability of the E-22 subject was categorized at the Informal deduction stage.

3.6. E-17 Capability Analysis

E-17 subjects are categorized at a high level of self efficacy. At the visualization stage, subjects E-17 have been able to draw a figure and can identify a figure with a complete appearance. Although, there are images that are less proportional in size.

In the analysis phase, subject E-17 is able to identify relationships between parts of a building, interpret verbal descriptions about shapes, say shapes based on certain properties and be able to solve geometry problems by using known building properties.

At the informal deduction stage, the two subjects have fulfilled all the indicators at the informal deduction stage even though sometimes there are steps that are not written in full. The findings in the field, there is one indicator at the deduction stage that has been fulfilled by subject E-17 namely identifying different possible strategies for finding a solution. However, for the next two indicators not yet fulfilled, the Van Hiele geometry thinking ability of subject E-17 is categorized at the Informal deduction stage. The explanation and answers given are quite complete but, the subject of E-17 lacks confidence in the delivery.

3.7. Development of Van Hiele's Geometry Thinking Ability Students in Learning 7E-Learning Cycle

The Experiment class used 7E-Learning Cycle learning with three meetings, beginning with self efficacy questionnaires. After the last study was given an essay test of Van Hiele geometry thinking skills in solving open ended problems in congruence and congruence material. The following is the average grade of class IX A as an experimental class of Mid Test scores, quizzes and essay tests on the ability to think geometry can be seen in Table 2.

Table 2. The Grade Average

	Mid Test	Quiz 1	Quiz 2	Quiz 3	Essay Test
The Grade Average	82	82	80	84	84.5

Based on table 3, the researcher assumes an increase in the grade average occurs because students begin to get used to working on open minded problems even though there are still some students who have difficulty with open minded questions. Learning 7E-Learning Cycle trains students to connect their knowledge with the knowledge they have just received. In addition, according to research conducted by Ruslan & Santoso (2013: 139) that by giving open ended questions can develop students' reasoning abilities. In addition, experience is very meaningful in the development of students' thinking abilities in accordance with the principles of constructivist learning theory. Some experts who support this principle are Piaget and Vygotsky. This is supported by the statement of Joyce (2011) in Tyas et al. (2015: 259) that efforts to help students improve their ability to obtain knowledge and skills with learning models. Meanwhile, according to Darojat et al. (2013: 5) learning model 7E-Learning Cycle is a quality learning model.

After the essay test is done some students say that they still experience confusion in working on open minded questions. This is possible because students are accustomed to working on open ended questions. According to Slavin (1994) in Damaryanti et al. (2017) that students can find their own concepts in teaching and learning activities if students are involved more actively to solve problems. In addition, there are factors that influence the success of students in developing the ability to think geometry, namely self efficacy. The development of Van Hiele's geometry thinking skills in solving open ended problems is seen in the following graph.

Based on these graphs, it can be concluded that the development of Van Hiele's geometry thinking skills in solving open ended problems in learning the 7E-Learning Cycle has increased.

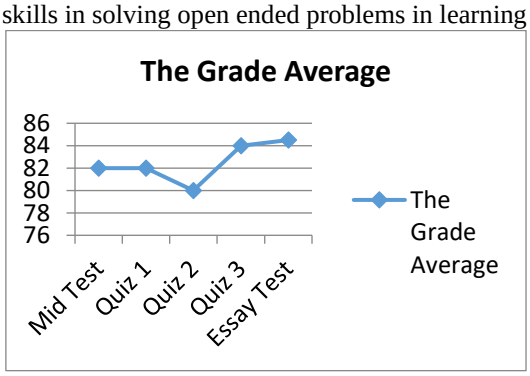

Figure 2. Development of Van Hiele's Geometry Thinking Ability in Solving Open Ended Problems In Terms of Self Efficacy

After conducting research activities in class IX A, it was found that from 33 students, there were 5 students of low self-efficacy type, 25 students of medium self-efficacy type, and 3 students of high self-efficacy type. The percentage of low, medium, and high self-efficacy types is 15%; 76%; and 9%.

In this study, the type of self-efficacy in the study class is dominated by the type of medium self-efficacy. Self-efficacy students in learning mathematics tend to be less active in asking, quiet, shy, lack of initiative to find out themselves and still need to be guided in learning mathematics in the classroom. Strategies that can be carried out by the teacher to students of self-efficacy are being able to improve the ability to think geometry and other mathematical abilities by increasing students' self-confidence in learning mathematics, especially on geometry material. Teachers need to encourage students to continue to be active in learning in the classroom.

The second type of self-efficacy that many students have is low self-efficacy. Students tend to be more passive than groups of students with medium self efficacy. Lack of expressing opinions, rarely asking questions when learning takes place, able to provide solutions to problems given by the teacher but on the other hand tend to be crowded in the classroom. The teacher can apply the strategy by applying a model that is able to attract the attention and interest of students in learning mathematics.

The type of self-efficacy that most students have is high self-efficacy. Students tend to be brave to express opinions, actively provide solutions to problems and are active in group discussions. Teachers can implement strategies by applying models that are able to maintain the focus and interest of students in learning mathematics.

4. Conclusion

Based on the results of research and discussion obtained the following conclusions. (1) The development of Van Hiele's geometry thinking skills in solving open ended problems in learning 7E-Learning Cycle in terms of the results of the class average shows an increase. (2) The ability to think geometry of students is high in self-efficacy, fulfilling indicators to the stage of informal deduction geometry thinking. (3) The ability to think geometry learners self-efficacy is medium, meet the indicator to the stage of thinking geometry analysis. (4) The ability to think geometry learners of self efficacy is low, meeting the indicators up to the stage of thinking geometry of analysis.

References

Al-Absi, Mohammad. (2012). The Effect of Open-Ended Tasks- as an assement tool- on Fourth Graders' Mathematics Achievement, and Assesing Students' perspectives about it. *Jordan Journal of Educational Sciencs*, 9(3), 345-351.

Bandura, A. (1994). *Self Efficacy*. New York: Academic Press.

Bandura, A. (1977). Analysis of Self-Efficacy Theory of Behavioral Change. *Journal for Cognitive Therapy and Research*, 1(4), 287-310.

Bandura, A. *Self Efficacy in Changing Societies*. New York: Cambridge University Press.

Burger, W. F., & Shaughnessy, J. M. (1986). Characterizing the van Hiele levels of development in geometry. *Journal for research in mathematics education*, 17(1), 31-48.

Damaryanti, D., Mariani, S., & Mulyono, M. (2017). The Analysis of Geometrical Reasoning Ability Viewed from Self-Efficacy on Connected Mathematic Project (CMP) Learning Etnomathematics-Based. *Unnes Journal of Mathematics Education*, 6(3), 325-332.

Darojat, L., & Kartono. (2016). Kemampuan Pemecahan Masalah Siswa dalam Menyelesaikan Soal Open Ended Berdasarkan AQ dengan Learning Cycle 7E (Students' Problem Solving Ability In Solving Open Ended Problems In Terms of AQ with 7E Learning Cycle). *Unnes Journal of Mathematics Education Research, 5(1), 1-7.*

Eisenkraft, A. (2003). *Expanding the 5 E Model A purposed 7 E model emphasizes "transfer of learning" and the importance of eliciting prior understanding*. National Science Teachers Association, 1840 Wilson Blvd., Arlington, VA 22201-3000.

Moleong. (2011). *Metodologi Penelitian Kualitatif* (Qualitative Research Methods). Bandung: PT Remaja Rosdakarya.

Muarifah, A. (2016). Analisis Keterampilan Geometri Siswa dalam Menyelesaikan Soal Geometri Segiempat Berdasarkan Tingkat Berpikir Van Hiele (Analysis of Students' Geometrical Skill In Solving Equilateral Problems In Term Of Van Hiele's Thinking Level). (*Undergraduate's Thesis)*. Semarang State University.

NCTM. (2000). *Principles and Standards for School Mathematics*. America: The National Council of Teachers of Mathematics, Inc.

Ruslan, A. S., & Santoso, B. (2013). Pengaruh Pemberian Soal Open Ended Terhadap Kemampuan Penalaran Matematis Siswa (The Impact of Given Open Ended Problems on Students' Mathematical Reasoning Ability). *Kreano*. 4(2), 138-150.

Sefiany, N., Masrukan, Zaenuri. (2016). Kemampuan Komunikasi Matematis Siswa Kelas VII Pada Pembelajaran Matematika Dengan Model Knisley Berdasarkan Self Efficacy (7th Grade Students' Mathematical Communication Ability in Knisley Model In Terms Of Self Efficacy). *Unnes Journal of Mathematics Education*, 5(3), 227-233.

Sugiyono. (2015). *Metode Penelitian (Research Methods)*. Bandung: Alfabeta.

Tyas, M.A., Mulyono, Sugiman. (2015). Keefektifan Model Pembelajaran Learning Cycle 7E terhadap Minat Belajar dan Pemahaman Konsep Matematika Kelas X (The Effectivity of 7E Learning Cycle Models On 10^{th} Grade Students Motivation and Mathematical Concept Understanding). *Unnes Journal of Mathematics Education*, 4(3), 258-264.

Villiers, M. (2010). Some Reflections on the Van Hiele Theory. *The 4th Congress of Teachers of Mathematics of the Croatian Mathematical Society*. Zagreb.

Wena, M. (2009). Strategi Pembelajaran Inovatif Kontemporer: Suatu Tinjauan Konseptual Operasional (Cotemporary Innovative Learning Strategy: An Operational Conceptual Study). Jakarta: Bumi Aksara.