Advances in Social Science, Education and Humanities Research, volume 287
1st International Conference on Education and Social Science Research (ICESRE 2018)

Hypothetical Learning Trajectory Of Students On Learning Geometry In Junior High School Grade 7th

Didi Suryadi[1]
Pendidikan Matematika
Sekolah Pascasarjana UPI
Bandung
ddsuryadi1@gmail.com

Muhammad Prayito[2]
Pendidikan Matematika
Universitas PGRI Semarang
Semarang
prayito@upgris.ac.id

Endang Mulyana[3]
Pendidikan Matematika
Sekolah Pascasarjana UPI
Bandung
Emul5657@yahoo.co.id

***Abstract*— Learning approaches to improve learning outcomes are constantly being improved. The purpose of this study is to find the proper learning trajectory on geometry material based on Van Hielle Theory. This study is a qualitative research by using didactical research design method. This Hypothetical Learning Trajectory (HLT) is compiled based on an analysis of the Learning Obstacle, level thingking of Van Hielle Geometry, and analysis of the curriculum. Initial analysis that begins with collectings data about learning obstacle are collected by analizing the student answer from test and learning process.**

Keywords*— Lesson , Van Hielle, Hipothetical Learning Trajectory, Students

I. INTRODUCTION

Batang Regency has 62 junior high schools consisting of 15 private schools and 47 public schools. Based on the 2013 UN results ranking of SMP Negeri 2 Limpung with the number of 203 students ranked 30th out of 62 junior high schools in Batang Regency totaling 9830 students . The percentage of mastery of the subject competency of the National Examination in mathematics that contain numbers, algebra, geometry, statistics and opportunities shows that geometry has the lowest percentage. In the aspect of the ability of students about the elements and properties of 2-dimensional shape has a percentage of 35.96%, while the elements and properties of 3-dimensional shape has a percentage of 42.63% [1]. This value puts geometry into the hardest competency in the National Examination in mathematics.

Table 1. Percentage of results of mastery of material on mathematics problems at SMP Negeri 2 Limpung

No	Ability tested	Mastery percentage
1	Elements and properties of 3-dimensional shape	35,96
2	The concept of Probabilty theory	38,67
3	Elements and properties of 2-dimensional shape	42,63
4	Number operations, social arithmetic, sequence / series	42,94
5	Statistics: data presentation and measures of center and variability	63,42

Geometry competencies contained in the Common Core State Standards are two out of six competencies. Furthermore, in the elaboration of indicators, there are 11 indicators of geometry achievement from 25 indicators, which means that the percentage of the geometry achievement indicator at SKL is 44%. The indicators specified in Common Core State Standards are mostly problem solving. The problem solving in the indicator indicates the solution to the problems of everyday life, so that to solve it requires visualization of students with the right conditions. The percentage of the number of items in the National Examination relating to geometry is quite high, reaching 45%. Most of these questions are non-routine questions. Non-routine problem solving, among others resolve the problem in the context of mathematical or everyday life with the aim to make the students familiar grapple with similar problems, applying a mathematical procedure in the new context [2].

Limpung 2 Junior High Schools has begun implementing the 2013 curriculum since 2014 starting from class 1. Next Plan 2015 gradually began to explore other classes. But in 2015 the curriculum used by Limpung 2 Junior High Schools went back to the Education Unit Level Curriculum. The curriculum changes that occurred did indeed make the teacher have to fix the administration more. However, the learning carried out in the classroom still goes according to plan, which is to start applying the teacher as a facilitator in the classroom. This means that it will place students as centers of learning, as a result students are expected to be able to study independently both individually and socially.

Learning outcomes cannot be separated from the learning process experienced by students. Teachers need to consider the difficulties experienced by students during the learning process. According to [3] there are three types of difficulties that are usually faced by students. First, the difficulties caused by discrepancies in the child's ability level with the demands of thought contained in teaching materials. Second, the difficulties caused by the limited context in understanding a concept. Third, difficulties caused by mistakes or weaknesses related to the design of teaching materials.

[4]reveals five reasons why geometry is very important to learn,

(1) Geometry helps humans have complete aspirations about their world. For example, geometry can be found in everyday life such as the form of cylindrical milk cans,

the shape of a television screen that resembles a rectangle, the shape of a roof that resembles a pyramid, and others.

(2) Geometric exploration can help develop problem solving skills. For example students who will make a kite toy will be able to investigate the needs and sizes needed to make a kite toy.

(3) Geometry plays a major role in other mathematics. For example, triangular material in geometry will relate to trigonometric material, broad-based material is related to the concept of integral calculus.

(4) Geometry is used by many people in everyday life. For example, a construction worker would install ceramics in a new building, so the worker could apply burial material so that the purchase of ceramics could be a minimum.

(5) Geometry is full of puzzles and fun. For example, the puzzle looks for the number of rectangles in the following picture.

.

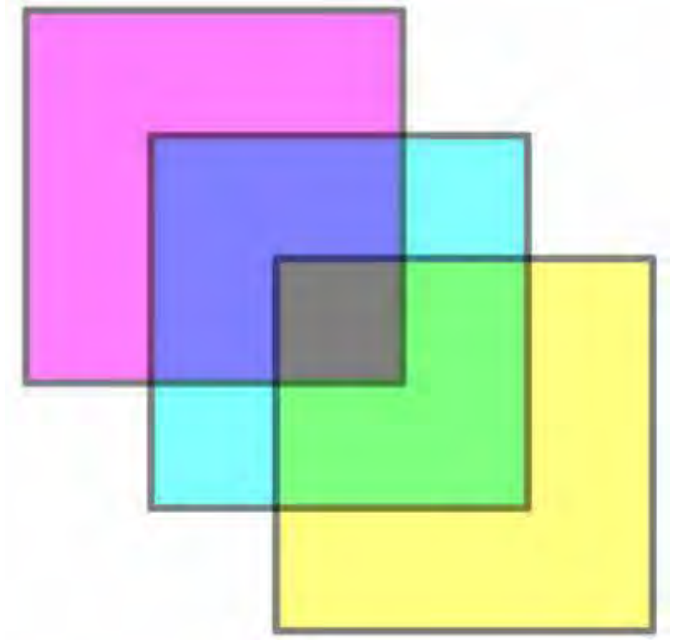


Figure 1 rectanguler mind breaker.

II. THEORETICAL STUDY

A. Mathematics Learning Theory

The integration between the concept of learning and the concept of teaching gives birth to a new concept called the teaching and learning process or by another term called the learning process. According [5] understanding of the teaching and learning process is an educational communication process that requires careful and mature planning, especially in terms of procedures for implementation and minimum criteria for success.

According to [6], states that: mathematics instructors should be guided by how to teach mathematics so that learners of mathematics are better suited to say "teaching learning mathematics" rather than "learning to teach mathematics". So there are basic things that must be considered, namely, the first teaching orientation is that students learn mathematics, and the second is to learn mathematics. If the learning process of mathematics is good, it can be expected that the learning outcomes of students will be good too. With a good mathematics learning process, subjects who learn will be able to understand mathematics further and easily apply it to new situations, which can solve problems both in mathematics itself and other sciences or in everyday life. Learning and learning can be seen as a comprehensive process that must be directed to the interests of students, namely learning.

B. Van Hielle teory

Five levels of thinking according to[7] will be passed by students in learning geometry. In the *visualization* / *visualization* stage students can create field images in accordance with the concept regardless of the properties of the components. Then in the *analysis* / *analysis* stage students can make informal analyzes of the components and properties of geometry. At the level of *abstraction* / abstraction students can make abstract definitions and distinguish necessary requirements and sufficient terms of a geometrical concept. Furthermore, at the level of *deduction* / deduction students can make a formal analysis with a complete mathematical system context with undefined terms, axioms, truth logic systems, definitions and theorems. At the *rigor* / accuracy level students can compare systems based on different axioms and can learn geometry variations.

According to Van Hiele, every student learns geometry through the levels above in the same order. However, the time when students enter a level can be different. It is possible that in a particular section of geometry, a student has reached a rather high level while in another part he is still at a lower level. the progress of the level of development of thinking of a student is not much dependent on his maturity, but is much influenced by the learning process. Thus a good organization between methods, time, material, and learning plans that are used at a certain level can improve students' thinking ability in the learning material.

C. Visualization Capability

[8] say that visualization is ability, process and product from creation, interpretation, use and reflection of pictures, diagrams, in mind on paper or with technology, with the aim of describing and communicating information, think and develop ideas that were previously unknown and advance understanding . Visual imagination can clarify the various facts of the problem of geometry, this means that in constructing an intuitive understanding visualization is needed as the basis for intuitive reasoning needed in mathematics learning.

III. RESEARCH METHOD

This research was conducted by researchers to design learning designs based on learning obstacle analysis experienced by students in learning geometry of class VII . The method used for this research is qualitative research. Qualitative methods are used to get in-depth data, a data that contains meaning. The research design used by researchers in this study was Didactical Design Research (DDR). According to [9]Didactical Design Research basically consists of three phases, namely: (1) analysis of didactic situations before learning in the form of Didactic Hypothesis Design including ADP, (2) analysis of metaditional inactivity, and (3) retrospective analysis namely linking analysis the results of a hypothetical didactic situation analysis with the results of the analysis of metadactic didactics . Of these three stages will be obtained Empirical Didactic Design which is not possible to continue to be refined through the three stages of DDR.

A. Subject

Didactical Research Design Research (DDR) will be performed at the Junior High School State 2 Limpung Batang Regency. The population of this study was the seventh grade students of Junior High School State 2 Limpung. While the research sample is students of Class VII-B. Researchers take as many as 32 students to obtain data.

B. Instruments

The main instrument of qualitative research is the researcher itself, but then after the focus of the research becomes clear, it is likely that a simple research instrument will be developed, which is expected to complete the data and compare with the data found through observation and interviews. In addition, qualitative research also functions to determine the focus of research, selecting informants as data sources, conducting data collection, assessing data quality, analyzing data, interpreting data, and making conclusions on its findings. The researcher also made an instrument to test learning obstacle by developing a learning design based on the analysis of learning obstacle experienced by students and an instrument to determine the ability to think geometry of students .

C. Data analysis technique

In this study researchers used two kinds of instruments for data collection, namely tests and non-tests.

1. Test

   In the test instrument, the researcher uses a test instrument, which is a learning achievement test instrument to test the learning obstacle experienced by students then to measure the success of Van Hiele theory learning design in class VII geometry learning.

2. Non Test

   a. Observation

      Observations were made to observe the implementation of class VII geometry learning in accordance with the learning plan. In this case the learning planning carried out is adjusted to the steps of the Van Hiele learning phase.

   b. Interview

      The interview was conducted in order to obtain more complete and in-depth information about the attitudes of students about learning mathematics about class VII geometry based on the design that had been made.

   c. Questionnaire

      Questionnaires were given to students to find out the students' responses after getting Van Hiele based geometry learning.

   d. Documentation

      Documents in the form of images to support or complete research data in the form of written and oral documents when the research is carried out. .

      ..

IV. RESULT AND DISCUSSION

The material used in this study is the geometry of the flat-building geometry of class VII junior high school (SMP). The basic competencies of geometry in flat-build material which are the subject of research are regulated in Permendikbud number 024 of 2016 concerning core competencies and basic competencies. Permendikbud number 024 of 2016 was the result of a revision of the 2013 curriculum which at the beginning of Permendikbud number 68 of 2013 concerning basic competencies and structure of the curriculum of SMP-MTs. The division of types of competencies in Permendikbud number 024 2016 has similarities with Permendikbud number 68 in 2013, namely core competencies are divided into 4 (core competencies, spiritual attitudes, core competencies, social attitudes, core competencies of knowledge and core skills). The core competencies of knowledge in Permendikbud number 024 of 2016 attachment 15 are also still the same as the core competencies in Permendikbud Number 68 in 2013, namely "Understanding knowledge (factual, conceptual, and procedural) based on their curiosity about science, technology, art, culture related phenomena and an eye-visible incident.

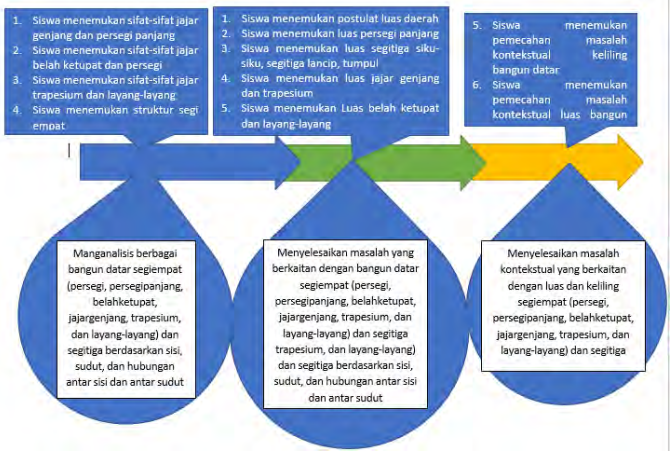
Basic competencies in basic skills knowledge and competencies there was little change in Permendikbud number 024 2016. The basic knowledge competencies in Permendikbud number 63 in 2013 were "3.6 Identifying the properties of flat building and using it to determine perimeter and area", "3.7 Describing the location of objects in Cartesian coordinates "," 3.8 Estimating and calculating flat surface area that is irregular by applying geometrical principles "and" 3.9 understands the concept of transformation (dilation, translation, reflection, rotation) using geometrical objects ". Whereas the basic knowledge competencies in Permendikbud number 024 of 2016 are "3.11 Linking the perimeter and broad formulas for various types of rectangles (square, rectangular, rhombus, parallelogram, trapezoid, and kite) and triangles". Based on the level of cognitive taxonomy [10] Both of the basic knowledge competencies in Permendikbud above have a goal to the same level that is at the level of analysis. analyzing ability is very

important in geometry learning, analysis becomes second level after visualization at Van Hiele's level of geometry thinking.

The basic skills competency in Permendikbud number 68 of 2013 is "4.5 Applying the principles of transformation (dilatation, translation, reflection, rotation) in solving real problems", "4.6 Resolving real problems related to the application of rectangular, square, trapezoidal properties parallelogram, rhombus, and kite ". While the basic skills competencies in Permendikbud number 024 of 2016 are "4.11 Resolving contextual problems relating to the area and circumference of the rectangle (square, rectangle, rhombus, parallelogram, trapezoid, and kite) and triangle".

A. Hypotetical Learning Trajectory Preparation (HLT)

Based SKKD, syllabus and learning objectives, then the researchers draft the initial H ipotecital Learning Trajectoty number Flat quadrilateral. HLT contains three main components of learning trajectory, namely: 1) learning objectives to be achieved, 2) activities that support goals, and 3) mathematical expectations as a result of activities. The activities created will be based on the level of geometry thinking and geometric material concepts with the help of visualization mediaand contexts that are appropriate to the character of students. The initial HLT draft refers to quadrangular flat material content in accordance with the KTSP and 2013 Curriculum which was given material emphasis in accordance with the identification of learning obstacles that the researchers did before. Next is a flat-built trajectory hypothetical learning class VII of junior high school..



his HLT preparation has considered the level of students' cognitive abilities . The level of geometry thinking [7] that participants will go through is the five levels of geometry thinking according to Van. In the visualization / visualization stage students can create field images in accordance with the concept regardless of the properties of the components. Then in the analysis / analysis stage students can make informal analyzes of the components and properties of geometry. At the level of abstraction / abstraction students can make abstract definitions and distinguish necessary requirements and sufficient terms of a geometrical concept. Furthermore, at the level of deduction / deduction students can make a formal analysis with a complete mathematical system context with undefined terms, axioms, truth logic systems, definitions and theorems. At the rigor / accuracy level students can compare systems based on different axioms and can learn geometry variations

B. Didactic situation integration in trajectory hypothetical learning

situation the didactic built refers on the study of the concept of flat building with the daily phenomena that exist and is experienced by students related to flat building. With regard to the concept of flat building researchers adopted the Van Hielle geometry learning phases. According to van Hielle to study geometry as a whole there are 5 phases that can be done.

1) Phase I: Information

Students are introduced to the scope of the material. The teacher discusses the material to clarify the material so that students understand the scope of the material.

2) Phase II: Guided Orientation

In this phase, students are introduced to objects whose properties will be abstracted by students in learning. The purpose of this phase is for students to be actively involved in exploring these objects. The teacher directs and guides students to do the right exploration, through carefully structured tasks.

3) Phase 3: Excitation

In this phase, the intuitive knowledge that learners have re-elaborated becomes more explicit. In this phase students clearly realize the conceptualization of geometry material that they are studying, and describe it in their own language. The teacher introduces relevant mathematical terms.

4) Phase 4: Free Orientation

In this phase, students solve problems that the solution requires synthesis, utilization of concepts and relations that have been elaborated previously. The role of the teacher is to select the right material and geometry problems, to introduce relevant terms as needed.

5) Phase 5: Integration

In this phase, students make a summary of everything that has been learned (concepts, relations) and integrate their knowledge into a coherent network that can be easily described and applied. Language and conceptualization of mathematics are used to describe this network. Finally, ideas are summarized and integrated in formal mathematical structures. At the end of phase 5, new levels of thinking have been achieved for the material being discussed.

The learning phase is arranged according to students' level of thinking. In the initial analysis it has been found that 40% of students in the VIIB class are in pre-level 0, which means students are still having trouble visualizing correctly. So as to support students' visualization , visualization teaching aids are used so students can understand the problem well [11] . In connection with the didactic situation designed by the researcher , [12] explains that the interaction between students

and teachers in a didactic situation contributes to the rules and modification of social norms for mathematical activities that are reflected in a didactic contract. Brousseau also emphasized that students must have the freedom to make responses to situations based on the known context of knowledge and the development of students' mathematical understanding.

Learning activities in the class contain the activities of students to construct comprehensive comprehension in building knowledge with the help of visual aids. Learning activities are arranged according to the learning trajectory of students in geometrical material. the aid of visual aids is used because it passes through various considerations and interviews with students regarding the tools students like for learning in class. Visual teaching aids will help students interact directly with the geometric objects being studied. Interaction is done more than just looking at geometric objects, so students will better understand the concept of geometry. then students can solve problems with new ideas at the integration stage. Based on the trajectory hypothetical learning, it will coexist with lesson design that details student activities clearly. Teacher input is to achieve learning according to the didactic situation, the student's response will be predictable. So the teacher has prepared a didactic and pedagogical anticipation for the conditions that will occur.

ACKNOWLEDGMENT

Thanks to the Directorate of Research and Community Service Directorate General of Strengthening Research and Development Ministry of Research, Technology, Higher Education which has funded this research. LPPM Semarang PGRI University which has helped to conduct this research so that it runs smoothly..

REFERENCES

[1] "Aplikasi PAMER UN 2014 Tentang Laporan Ujian Nasional SMP/MTs Tahun Pelajaran 2013/2014." BSNP(Badan Standar Nasional Pendidikan).

[2] D. Suryadi, *Membangun Budaya Baru dalam Berpikir Matematik*. Bandung: Rizqi, 2012.

[3] D. Suryadi, *Kemandirian Pendidik*. Bandung: Sekolah Pascasarjana Universitas Pendidikan Indonesia, 2014.

[4] P. M. Van Hiele, *The Child's thought and geometry*. English translation of selected writings of Dina van Hiele-Geldof and Pierre M. van Hiele, 1959.

[5] S. Muhibbin, *Psikologi Belajar*. Jakarta: Raya Grafindo Perkasa, 2005.

[6] Herman Hudojo, *Strategi Mengajar Belajar Matematika*. Malang: IKIP Malang, 1990.

[7] P. M. Van Hiele, "Structure and insight," in *A theory of mathematics education*, Academic Pr, 1986.

[8] W. & C. Zimmermann, "Editor' Introduction," in *What is Mathematical Visualisation?Zimmerman W. and Cumningham S. (eds.) Visualisation in Theaching and Learning Mathematic*, D.c. Mathematical Association of America, 1991, pp. 1–8.

[9] D. Suryadi, "Menciptakan Proses Belajar Aktif," in *Kajian dari Sudut Pandang Teori Belajar dan Teori Didaktik.*, 2010.

[10] D. R. Krathwohl, "A Revision of Blooms's Taxonomy," in *An Overview",Theory into Practice*, vol. 41, no. 4, College of Education: The Ohio State University, 2002.

[11] N. Presmeg, "Visualization in High-School Mathematics. For the Learning of Mathematics," *J. Educ. Stud. Math.*, vol. 6, no. 3, pp. 42–46, 1986.

[12] Brouseau, *Theory of Didactical Situation in Mathematics*. Dordrecht: Kluwer Academic Publicer, 2002.