Practicality of geometry learning set based on van hiele theory to increase students’ mathematical communication ability

Y D Andila¹ and E Musdi*¹

¹Mathematics Department, Universitas Negeri Padang, Padang, Indonesia *corresponding author: win_musdi@yahoo.co.id

Abstract. Geometry is one of the important subject in mathematics. One of the objectives of learning geometry is the students can gain confidence about their mathematical abilities and be able to communicate mathematically. However, in their practices students are still having difficulty understanding geometric material and students’ mathematical communication skills are also still low. Considering the importance of geometry learning, the students’ mathematical communication ability need to be improved to achieve geometry leaning goals. In this study, geometry learning devices were developed based on the Van Hiele Theory with the purpose to produce a product consisting of lesson plan and students worksheet to develop students’ mathematical communication ability. The development model used is Model Plomp. Based on the results obtained in small group stage, there is increase in students’ mathematical communication ability seen from the result of working the questions every meeting. Then, an analysis the questionnaire of students who obtained practical category. So that, it can be conclude that geometry learning sets based don Van Hiele Theory practical can be used to increase Students Mathematical Communication Ability in Class VII Junior High School.

1. Introduction

Geometry is one part of mathematics and is important topic in school mathematics [1]. Usiskin in [2] give reasons why geometry needs to be taught, that is: first, geometry is the only field of mathematics that connect mathematics with physical form in the real world. Second, geometry is the only things able to that can enable mathematical ideas that can be visualized. Third, geometry can provide a non-singular example of mathematical system. Based on the description that has been stated, it seems logical to us that the role of geometry in mathematical material is very strong. Not only because geometry is able to foster the thinking process of students, but also strongly supports many other topics in mathematics. So, students should be able to understand geometry properly and correctly.

The purpose of learning geometry is the students can gain confidence about their mathematical abilities, be good problem solvers and can communicate mathematically [3]. Therefore, it is necessary to develop mathematical communication skills of students in learning geometry.

Based on the results of observation at SMPN 13 and 30 in Padang, show that learning is still not centered on students, so students are less active in the learning process. For geometry learning, students are only to seeing abstract image and memorizing geometric shapes without understanding the properties of the form. Besides that, learning activities still do not facilitate and optimize students’ mathematical communication ability. Students are still difficult in expressing mathematical ideas and presenting a problem into mathematical symbol. Based on Table 1, show that result students mathematical communication ability is still low.
Table 1. Result Test of Students Mathematical Communication Ability

| Test | Indicator | Scale 0 | Scale 1 | Scale 2 | Scale 3 | Scale 4 | Average | Percentage |
|------|-----------|---------|---------|---------|---------|---------|---------|------------|
| 1    | Presents problems in language or mathematical symbols. | 5 | 30 | 17 | 3 | 2 | 1.42 | 35.5% |
| 2    | Explain mathematical ideas and situations in writing with pictures. | 4 | 27 | 16 | 8 | 2 | 1.59 | 39.75% |

Based on Table 1, it can be seen that only 2 persons reach the ideal scale and most students get a scale of 1 and 2. Then, 30% of the student reach the minimum score standard. This is show the mathematical communication ability of students is still low. Based on these problems it is necessary to find the right way in learning mathematics oriented to students so that it becomes more active and the right way to teach geometry to students according their ability level. As for the alternative solutions for the problems outlined above is the development of geometry learning set based on Van Hiele theory.

The choice of Van Hiele theory as basis for learning the development of understanding and communication of student’s geometry on the grounds: Van Hiele’s theory focuses on learning geometry and Van Hiele’s theory provides a level of hierarchy in learning geometry where each level has its own symbols and languages. The five levels of geometry thinking according to Van Hiele [4] are: (1) Visualization, (2) Analysis, (3) Informal Deduction, (4) Formal Deduction, and (5) Rigor. The level of students’ thinking is determined by the learning process they go through. To move from one level to the next requires learning experiences that can be obtained from the stages of the implementation of learning. There are five stages of Van Hiele’s theory that support the learning process including: Stage 1: Information; Stage 2: Direction Orientation; Stage 3: Explication; Stage 4: Free Orientation dan Stage 5: Integration.

2. Method
The method is research and development (R&D). Development research is a method used to develop a new product or validate products used in education and learning [5].

![Figure 1. Formative Evaluation Layer [6]](image-url)
The development model used is the Plomp model which consists of three phases, namely the initial investigation phase (preliminary research), the phase of development or prototype making (prototyping phase), and assessment phase [6]. But, what was discussed in this article only development or prototyping phase. Plomp model was chosen because it has several advantages that can be seen through the assessment of its practicality, namely one to one, small group and field test [7]. The subject of this study were mathematics teachers and students in class VII SMPN 13 Padang. Seventh grade students involved in the trial stage of one-to-one evaluation amounted to three persons, students involved in the small group stage trials amounted to six persons, and 28 students in one class were used as implementers of Van Hiele theory learning on field test stage. The thing that will be discussed is the practicality of learning sets in the field test.

The data collection instruments used were students questionnaire sheets, and observation sheets of the implementation of the geometry based lesson plan Van Hiele theory. Before the instrument is used, it is first validated by 3 mathematicians. The techniques of collecting data are analysis of the observations of the implementation result in the learning process, and analysis of questionnaire data. Data analysis techniques for practicality questionnaires using a Likert scale. The Likert scale is arranged in a positive category, so that positive statements score according to Arikunto stated, score 4 for strongly agree statement (SS), score 3 for agree statement (S), score 2 for disagree statement (TS), score 1 for statements strongly disagree (STS) [8]. To determine the practicality value of the learning set, the formula according to what was stated by Purwanto was used. Learning sets have been said to be practical if the average practical assessment results are more than or equal to 75 [9].

3. Result and Discussion
The stages of geometry learning based on Van Hiele theory can facilitate the level of thinking of students’ geometry and improve students’ mathematical communication ability. Learning based on Van Hiele theory can help students overcome difficulties in learning geometry [10]. Through the learning stages Van Hiele can develop mathematical communication ability of elementary school students [11]. Based on the results of the study, in general students of SMPN 13 Padang are at level 2 thinking level, namely informal deduction. Students are this stage are able to determine the relationship between the properties of the object being observed. It also can provide definitions, arguments and reasons.

The practicality of the geometry learning set based on Van Hiele’s theory can be seen from the results of observing the learning process at the small group stage, namely through the practicality of the students’ response questionnaires and the implementation observation sheet. Based on the result of the questionnaire practicality of students’ responses, it was found that the LKPD based on Van Hiele theory for every aspect was in the practical category or very practical. The average percentage of LKPD practicality based on Van Hiele theory is 83.21% with a very practical category. The results of the analysis practicality of students worksheet based on Van Hiele theory can be seen in Table 2 below.

| Aspect       | Average | Percentage Practicality (%) | Category   |
|--------------|---------|-----------------------------|------------|
| Presentation | 3,43    | 85,83                       | very practical |
| Easy of use  | 3,21    | 80,36                       | practical   |
| Legibility   | 3,33    | 83,33                       | very practical |
| Time         | 3,33    | 83,33                       | very practical |
| Average      | 3,325   | 83,21                       | very practical |

Table 2. Result of students questionnaire sheets to students’ worksheet based on the Van Hiele theory
Next, to see the practicality of the Van Hiele theory based lesson plan, it can be seen based on the observations of the implementation of the lesson plan which was assessed by the observer. Based on Table 3 show that results of the observation sheet of the implementation of the Van Hiele theory based geometry lesson plan in the small group trial stage.

**Table 3. Result of observation sheet of the implementation of the geometry based lesson plan Van Hiele theory**

| Aspect                              | Percentage (%) | Category |
|-------------------------------------|----------------|----------|
| Introduction Activities             | 92.5           | SP       |
| Core Activities                     | 86.94          | SP       |
| Close Activities                    | 94.79          | SP       |
| Learning materials, media and resources | 83.33         | SP       |
| Assessment                          | 79.16          | P        |
| Language                            | 85.41          | SP       |
| Time                                | 87.5           | SP       |
| **Average Practicality (%)**       | **87.06**      | SP       |

Based on Table 3, it can be seen that the practicality of geometry lesson plan for each aspect is in the practical category or very practical. The overall practicality value of the lesson plan is 87.06% with a very practical category. So it can be concluded that the geometrical lesson plan based on Van Hiele theory is very practical at the small group stage.

The observations showed an increase in students’ mathematical communication ability based on the results of the student quizzes at each meeting on the material rectangles and triangles. Graph development of mathematical communication ability of students at the small group evaluation stage can be seen in the following figure.

**Figure 2. Mathematical Communication Ability of Students**

4. **Conclusion**

Based on the analysis of students questionnaire, observation sheets of the implementation geometry based lesson plan Van Hiele theory and the result of student quiz scores every meeting that has increased, it can be concluded that geometry learning sets based on Van Hiele theory practical can be used to increase students mathematical communication ability in Class VII Junior High School.
References

[1] Jupri A 2018 Using the van hiele theory to analyze primary school teachers’ written work on geometrical proof problems J. Phys.: Conf. Ser

[2] Safrina K, Ikhsan M, Ahmad A 2014 Peningkatan kemampuan pemecahan masalah geometri melalui pembelajaran kooperatif berbasis teori van hiele Jurnal Didaktik Matematika 1

[3] Sholihah, Zainatu S, Afriansyah, Aldila E 2017 Analisis kesulitan siswa dalam proses pemecahan masalah geometri berdasarkan tahapan berpikir van hiele Jurnal Mosharafa 6

[4] Breyfogle M and Lynch CM 2010 Van hiele revisited mathematics teaching in the middle school 16 232-8

[5] Sugiyono 2012 Metode Penelitian Pendidikan: Pendekatan Kuantitatif, Kualitatif, dan R&D (Bandung: Alfabet)

[6] Plomp T and Nieveen 2013 Educational Design Research Enschede: Netherland Institute For Curricuum Development (SLO)

[7] Arnawa IM, Yerizon, Nita S and Putra RT 2019 Int. J. Sci. Tech. Res. 8 287-92

[8] Arikunto S 2012 Prosedur Penilaian: Suatu Pendekatan Praktek (Jakarta: Rineka Cipta)

[9] Purwanto N 2012 Prinsip-prinsip dan Teknik Evaluasi Pengajaran (Bandung: Remaja Rosdakarya)

[10] Abdussakir 2009 Pembelajaran geometri sesuai teori van hiele Madrasah 2

[11] Nur’aeni E 2010 Pengembangan kemampuan komunikasi geometris siswa sekolah dasar melalui pembelajaran berbasis teori van hiele Jurnal Saung Guru 1 29-34