Developing Learning Instruments of Geometry Based on Van Hiele Theory to Improving Students’ Character

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Abstract. This development research aims to produce learning instruments of mathematics material geometry based on Van Hiele learning theory to develop characters which are valid, practical and effective criteria. The product consists of four components, namely: Lesson Plan, Student Book, Student Worksheet, and Learning Result Test. The process of developing using 4-D model Thiagarajan consisting of 4 stages namely define, design, development and disseminate. The result of the research shows that the learning tools developed are valid, practical, and effective based on the validator and the results of the experiments evaluated. The validity was measured based on experts' validation which meet the criteria of validity, with each Content Validity greater than 75%. This indicates that the four components are in valid category. The practicality was measured by instructional management sheet shown by the fulfillment of every aspect that is in both good and excellent category. The effectiveness was indicated by the fulfillment of 3 of the 4 defined effectiveness indicators, among others: (1) The average percentage of classical completion of the learning result test is more than 85%, (2) the fulfillment of 7 of the 9 categories of student activities, (3) a positive response of 85% of each aspect being responded.

1. Introduction
There are many problems we faced in education world like cheating in test day until plagiarism. Those we see and listen are concerning to one thing, that is character. In this case, education to be responsible because it products alumni whom good quality academically, however has less character. According to Mochtar Buchori¹²³⁴, character education should bring students to understand the values cognitively, to appreciate the values affectively, and the last to implement values in real situation. The problems of character education in level Secondary School should be studied, and alternative of solution should be found immediately, and it should be developed more operationally to be implemented easily in school. Character education aims to improve the quality and education result in school that leads to in achieving noble character of the students which intact, integrated and balanced, based on the competency standards of graduates.

Character education integration can be done in teaching geometry. Empirical facts show that many junior and senior high school students both in Indonesia and abroad lack understanding of geometry concepts. Van Hiele theory is selected as the basis of learning and study of learning materials because Van Hiele theory there is a theory that concerns the stages of thinking of students in the delegation of geometry and learning phase that can be used in the learning process. Van Hiele explains the stages of student's thinking development in geometry in five level: 1) Level of visualization, 2) Level of analysis, 3) Level of abstraction (informal deduction), 4) Level of formal deduction, and 5) Level of
Rigor (accurate), as well as several phases used in geometry learning consisting of five stages: 1) Inquiry / information, 2) Directed orientation, 3) explication, 4) Free orientation, 5) Integration. This theory aims to improve students’ understanding of geometry learning4,10.

Based on preliminary observation and interview dated March 3, 2017 to the mathematics teacher at one of Junior High School in Pangkep Regency South Sulawesi Province Indonesia, namely SMP Muhammadiyah Bungoro, he stated that the development of character education that they held up to now is still limited to the development lesson plan character. In addition, it is not yet at the level of development of teaching materials such as student character book and worksheet character. Based on that condition, the teacher should use instructional materials to assist the teacher in directing the learning process that integrates with the character values and helps the students to more easily understand the subject.

Thus, this study aims to produce learning instruments of geometry with the application of Van Hiele learning theory for the development of character education for students in grade VII. The instruments are the Lesson Plan, Student Book, and Student Worksheet.

2. Research Method
This research is a development research that develop the learning instruments of geometry based on Van Hiele learning theory to develop character referring to 4-D Thiagarajan model. This model consists of 4 stages, namely stage I define, stage II Design, stage III develop, and stage IV disseminate. Then, the subjects were 21 students on Grade VII of SMP Muhammadiyah Bungoro. The instruments in this study were: (1) validation sheet, (2) observation sheet, (3) student response questionnaire, and (4) students’ mastery test on the subject.

Then, analysis techniques in determining validity of data used “Gregory” formula which obtained from two validators1,2,6. Analysis of practicality was obtained from the observation of learning management during the learning process were carried out, analyzed, and described in the minimum category.

Analysis of the effectiveness of teaching instruments based on Van Hiele learning theory to develop character supported by the result of data analysis from 4 component effectiveness10, that are:

- Student Learning Outcomes or classical completeness, if at least 85% of students achieve a minimum score of 67, then the classical completeness has been achieved,
- Student Activity, if the observation results show that the student activity is within the specified tolerance range, observation of students’ activities only focused on two groups that have been determined by researcher as the focus of research. Observations were made by 2 people for each observer observing one group of students. The method used in observation is every four minutes, observers observe the activities of the students who are dominant they do and one minute later observers write down to the observation sheet provided.
- Student Response, criteria established if 50% of students respond positively to at least 70% of the number of aspects asked.
- Development of Student Character. There were 8 character value studied; critical, meticulous, logical, responsibility, unyielding, honest, respect, cooperation. The data about improvement of student character values during the learning process is obtained self-assessment questionnaires that filled by students and observation sheet of the development of character values that filled by observers.

3. Results and Discussion
There were four stages that have been conducted in this study to produce learning instruments of geometry. First, in the define stage shown about initial character of students that covering the background knowledge, the language used and the level of student cognitive development. The results of the study indicated that the most dominant character of students is less critical in responding to the subject matter. In addition, in this first stage it also conducted analyzing of topic in geometry. According to curriculum in Indonesia, the basic competence is identifying properties of triangle by
side and angle, identifying the properties of plane (rectangular, square, triangle, kite and trapezoid), calculating perimeter and area of plane, solving the real problems related to the application of the concept of perimeter and area of plane.

Second, draft of learning instruments, namely: Lesson Plan, Student Book, Student Worksheet and Test of Learning Outcomes were designed at the stage II. Third, at the develop stage, it can be seen about data of validator assessment which is provided by the two validators. The first validator gave score 4 and so did the second validator. Then, it was being calculated based on the content validity formula of Gregory and resulted $V = 100\%$. This means that the validity have “strong relevance” with the coefficient of content validity which more than 75% or $V> 75\%$. It can be stated that the developed learning instruments is valid. Next, based on the observation of the instruments used in the classroom, the observer stated that the learning instruments were implemented well during the learning process. The result shows that the ability of teachers in managing geometry class based on Van Hiele theory to improve students’ character was in good category. Thus, it can be concluded that learning instruments met the criteria of practicality.

Then about effectiveness, based on observational data of student activities, 7 of the 9 categories activities that observed were in tolerance range. Next, after applying geometry learning instruments based on Van Hiele to develop characters, it has been conducted test and the result can be seen in the following table.

| Score   | Category     | Frequency | Percentage |
|---------|--------------|-----------|------------|
| 0 – 34  | Very Low     | -         | -          |
| 35 – 54 | Low          | 1         | 4,76       |
| 55 – 64 | Immediate    | 2         | 9,52       |
| 65 – 84 | High         | 9         | 42,85      |
| 85 – 100| Very High    | 9         | 42,85      |

Table 1 shows that there are 18 students who complete the study or who reach the completeness of the individual (students who score 60-100 provisions of the school or about 85.714\%). So the number of students who have not completed (students whose score 0- 59) is 3 students from 21 students or about 14.285\%. This data shows that the classical completeness was achieved. Besides that, the result of questionnaire shows that 19 of 21 students (90\%) responded positively to learning process and instructional instruments. Then, during the learning process the character observed consists of 8 values that each contains several indicators. The result of analysis of character improvement data toward eight students (both groups of observation) shows that from 8 characters, there is still one character, namely “critical”, is in the category rising visible. This means that the value of “critical” character still needs to be improved. It has been stated previously in that the criteria of the effectiveness of learning instruments include: (1) mastery of learning outcomes, (2) student activities, (3) student responses, (4) character value development. Based on the experimental results of learning tools are in the effective category. From the four indicators above, only 3 aspects are met in the trial of instruments in learning process, while the aspect that has not met the criteria of effectiveness is the development of the students’ character values because there are still characters that want to be developed, namely critical character. That character was rising to be seen at the end of the learning process (during the research).

Lastly, stage IV “disseminate”, was implemented in a limited and simple manner with limited dissemination to mathematics and non-mathematics teachers of SMP Muhammadiyah Bungoro. From the results of the dissemination obtained some suggestions and used to revise the initial draft into the final draft as the final development of mathematics learning instruments.

In this study there were also specific findings obtained during the experimental learning of mathematics learning materials based on geometry of Van Hiele learning theory to develop the character. Those will be described as follows:
The first finding concerns student learning outcomes on triangular and quadrilateral geometry materials. The application of learning tools based on Van Hiele Learning Theory has made a positive impact on the achievement of the students’ learning quantity. Result Test showed that of 21 students who took the test, there were no students who were in very low category. 1 student is in low category (4.76%), 2 students (9.52%) is in medium category, 9 students included in the high category (42.85%) and 9 students (42.85%) are in very high category.

The second specific finding concerns to students’ activities. Overall, based on result analysis shows that all of categories observed for each meeting are at tolerance range.

The third specific finding concerns to students’ responses, in trial of learning instruments shows that 90% of students has given positive responses toward learning process, students book, and students worksheet.

4. Conclusion
For character development, generally it can be seen that the result of application of developed learning instruments of geometry based on Van Hiele learning can improve students’ character values that is critical character value, meticulous, logical, responsibility, unyielding, honest, respect, cooperation. Critical character was still in the rising visible, whereas the other seven characters were already in the expected category. To sum up, it can be concluded that result of the developing learning instruments of geometry based on Van Hiele theory to improving students’ character was obtained valid, practice, and effective.

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