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The Use of Van Hiele Theory to Enhance Pupils' Understanding of the Characteristics of Simple Shapes

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Abstract : This research is motivated by the undeveloped creativity of teachers in developing pupils' ability to understand the characteristics of simple shapes. The teacher's role as a centre of learning or teacher centred approach often limits the space for pupils to explore, and lessens their opportunities to explore their own capabilities and knowledge. Studying this way is only a transfer of knowledge from the teacher to the pupils, so that pupils only learn by rote rather than by understanding. One solution to the above problems is to apply the Van Hiele theory to the material properties of simple shapes. The aim of this study is to describe the application of Van Hiele's learning theory to improve pupils' understanding of the characteristics of simple shapes. The different stages of learning in Van Hiele's theory include the information stage, directional orientation, explanations, free orientation and integration, making the pupils able to understand and even being involved directly in the learning. Pupils are faced with situations that encourage them to express their opinions based on what they observe, thus indirectly able to find solutions to problems they face. The method used in this research is a quasi-experimental design with a nonequivalent control group. The design of this research featured two groups: the experimental group and the control group, who were all third year pupils of SDN Bantarsari Bungursari, Tasikmalaya. The techniques used for gathering data were tests and observation. The outcome of the research was that there was a greater increase in the pupils understanding of geometry using Van Hiele's theory compared to pupils who experienced conventional learning.

Keywords : Van Hiele Theory, Concept, Characteristics.

1. INTRODUCTION

A pupil is expected to master various educational fields to achieve the goals of primary school education standards. One area of knowledge that is important is Mathematics. Mathematics is one element of education that is in all phases of Elementary School education; "Mathematics is one of the subject areas that exists at all levels of education, from elementary school to college." (Susanto 2013, p184). In elementary schools, mathematics education has become a benchmark for one's success in acquiring knowledge of mathematics further on in their education. Mathematical competency standards formulated in the curriculum MONE, 2004 (Susanto, 2013, pp 184) include an understanding of mathematical concepts, mathematical communication, mathematical connections, reasoning and problem solving, as well as a positive attitude and interest towards mathematics.

One of the learning materials in primary school mathematics is geometry. Geometry is derived from the Greek words 'geo' meaning earth and 'metro' meaning measure. Geometry is a branch of mathematics which was first introduced by Thales (624-547 BC) relating to spatial relationships (Iswanto, 2012). Learning Geometry is closely related to human life. Abdussakir (2010) states, "Geometry is used by everyone in daily life" and subconsciously pupils are familiar with these concepts long before they encounter them at school.

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For this reason, a teacher needs to use the environment that the pupils are from in their teaching because pupils' first knowledge comes from the neighborhood where he or she lives. Though pupils often come across these concepts in their daily lives, there are a few pupils in the school who do not understand the concept of geometry correctly. This problem should be a concern for teachers, furthermore Sudarman states that "among the various branches of mathematics, geometry occupies the position of most concern". (Abdussakir 2010). It is often seen as a burden for teachers to improve the quality of learning, especially to improve pupils' understanding of the basic concepts of geometry.

One of the properties of geometry is simple flat shapes. The basic problems that researchers found in Class III SDN Bantarsari Bungursari Tasikmalaya (Bantarsari Bungarsari Primary School in Tasikmalaya, West Java Indonesia) were that pupils were only able to mention the name of a flat shapes and the characteristics of the flat shape. The findings in the field arose due to the way that teachers usually transferred knowledge to pupils. Embedded deep in pupils thinking was 'what had only been taught by the teachers' thus leading to an immediate verbal response rather than an understanding and exploration of the materials based on the student's own observations. Pupils understood via rote learning, rather than by observing and understanding, which in turn meant pupils could possibly forget the material. This differs to the situation where pupils experience and observe the subject matter themselves at different times and who later will be able to remember and apply it by themselves at a later time.

Student success cannot be separated from the role played by the teacher and his/her position within the school and within the learning process. The teacher as a spearhead in the implementation of education is a very influential part of the learning process (Susanto, 2013, p. 92). Teachers are required to be creative in applying a theory of learning or select appropriate models, methods and learning media. This is in line with Rusman's statement that, "in managing learning activities, various materials and a variety of media, methods, sources, and other supporting factors are used" (2013: 71). Learning that uses only conventional approaches where knowledge is only transferred from teacher to pupils with the student only having to memorize material without developing their own understanding, does not make learning meaningful for pupils.

Based on this discrepancy between these two types of learning, it is necessary that learning directly involves pupils, thus creating a meaningful learning experience. Pupils can connect real life experiences and help them to understand the concepts studied at school.

From the literature studied for this research, the researcher found stages of learning that are appropriate to the study of geometry, in particular Van Hiele's model/theory of learning.

The Van Hiele Model is a theory of learning that makes geometry a focus of cognition. In the Van Hiele theory, there are two issues, namely the level of thinking and the learning stage. With the implementation of the Van Hiele theory of learning, pupils are exposed to situations that encourage them to play an active role in observing and expressing opinions about a problem. (Nur.aeni.2010). Therefore, the researcher was encouraged to conduct research under the title "The use of Van Hiele theory of learning to enhance pupils' understanding of the concept of basic flat shapes " being undertaken in SDN Bantarsari Bungursari Tasikmalaya.

2. RESEARCH METHOD

The method used in this study is the quasi-experimental method. The design used is Non- equivalent Control Group Design, with the aim of determining differences in pupils' understanding of the concept of the properties of simple shapes amongst pupils where the Van Hiele Theory was applied and with pupils who experienced conventional teaching methods. The population in this study were the third year pupils of SD Negeri Bantarsari Bungursari, Tasikmalaya, using saturated sampling technique. In total there were 50 pupils with 25 pupils in Class A (the experimental group) and 25 pupils in class B (the control group). The research instruments used were tests and observation sheets. The observation sheets used to test the Van Hiele theory in the experimental class were based on the different stages of learning as developed by Van Hiele.

3. FINDINGS AND EXPLANATION

The findings are the research results, data from the pre-tests, post-tests and observations. The pre-test and post-test were performed on each class. In analyzing the data, the researcher used SPSS v.16 for Windows.

Pupils Initial Understanding of the concept of simple shapes. Tests were done in the experimental class and the control class to determine pupils initial understanding of the characteristics of simple shapes prior to the implementation of the materials/learning Data obtained from the pre-test were then grouped into category intervals based on the scores of the pre-test results as seen in Table 1.

Table 1
Interval Category Score Pretest Results

No.	*Interval*	*Cateogroy*	*Frequency*		*Percentage*	
			E	*C*	*E*	*C*
1.	$X \geq 75.05$	Very High	5	3	20 %	12 %
2.	$58{,}35 \leq X < 75.05$	High	6	9	24 %	36 %
3.	$41{,}65 \leq X < 58.35$	Average	4	4	16 %	16 %
4.	$24{,}95 \leq X < 41.65$	Low	6	7	24 %	28 %
5.	$X < 24.95$	Very Low	4	2	16 %	8 %

Notes :

E = Experimental Class
C = Control Class

Based on the pretest score results presented in Table 1 above, we can see that the initial understanding of pupils' concept of the characteristics of simple shapes in the experimental class is that 20% of pupils fall into the category of very high, 24% of pupils fall into the category of high, 16% of pupils fall into the middle category, 24% of pupils fall into the low category and 16% of pupils are in the very low category. As for the control class, 12% of pupils fall into the category of very high, 36% of pupils included in the high category, 16% of pupils fall into the middle category, 28% of pupils fall into the category of low and 8% of pupils fall into the category very low. Calculation interval categories based on the interval categories according to Rachmat and Solehudin (Muhlis, 2014, p. 30) are presented in Table 2 below:

Table 2
Interval Categories

No.	*Interval*	*Cateogry*
1.	$X \geq {}_{ideal} + 1.5\ S_{ideal}$	Very High
2.	${}_{ideal} + 0.5\ S_{ideal} \leq X < {}_{ideal} + 1.5\ S_{ideal}$	High
3.	${}_{ideal} - 0.5\ S_{ideal} \leq X < {}_{ideal} + 0.5\ S_{ideal}$	Average
4.	${}_{ideal} - 1.5\ S_{ideal} \leq X < {}_{ideal} - 0.5\ S_{ideal}$	Low
5.	$X < {}_{ideal} - 1.5\ S_{ideal}$	Very Low

The scoring is based on the following provisions obtained: X_{ideal} is 100, X_{ideal} is 50, and S_{ideal} is 16.7.

The highest pre-test scores in the experimental class were 90, while the lowest score was 0; the highest score in the control group was 100 and the lowest score was 0. The average score of the experimental class was 49.60 while the average score in the control class was 51.20. Based on the average scores

one can see there is little difference between the two classes. After the test, it can be concluded that the initial understanding between the experimental class and the control class were the same. At this point the research continued using the Van Hiele theory of learning in the experimental class and conventional learning in the control class.

Van Hiele Process-Based Learning Theory

Van Hiele based learning theory is based on the stages of learning Van Hiele applied to core activities. The stages include the study of information, free orientation stage, the stage of explanation, directional orientation phase and integration phase (Nur'aeni 2010, hlm.32). In the process of learning, the researcher played the role of teacher.

In the different stages of Van Hiele learning, pupils were exposed to situations that encouraged them to play an active role; pupils learned to give opinions based on observations. Pupils also learned to find their own solutions to the problems faced. Learning took place twice with the same learning indicators and learning objectives; however, at the second meeting core activities were further developed. The indicators and learning goals were:

Indicators

- State the name of simple shapes
- State the properties of simple shapes
- Specify which parts are the same length in a simple shape
- *d*. Apply the use of signs and symbols on a simple shape

Aim

Through observation of the media to form simple shapes, pupils can :

- State the name of simple shapes
- *b*.State the properties of simple shapes
- Specify which parts are the same length in simple shapes
- Apply the use of signs and symbols on a simple shape

The learning proceded well with pupils enthusiastic about expressing what they had observed. Pupils learnt to solve problems together, thereby embedding the learning outcomes in their memories; the pupils were directly involved in the learning process, thus gaining new life experiences.

The pupils final understanding of the characteristics of simple shapes. After learning in both classes, a post-test was conducted with both the experimental and control classes to measure the pupils understanding at the end. Based on the interval categories by Rachmat and Solehudin (Muhlis, 2014, p. 30), the research presented the following interval categories on poste -test scores, as in Table 3 below:

Table 3
Interval Category Score Post-test Results

No.	*Interval*	*Category*	*Frequency*		*Percentage*	
			E	*C*	*E*	*C*
1.	$X \geq 75.05$	Very High	17	12	68%	48%
2.	$58.35 \leq X < 75.05$	High	5	3	20%	12%
3.	$41.65 \leq X < 58.35$	Average	0	6	0%	24%
4.	$24.95 \leq X < 41.65$	Low	3	3	12%	12%
5.	$X < 24,95$	Very Low	0	1	0%	4%

Notes:

E = Experimental Class

C = Control Class

Pupils' final understanding of the characteristics of simple shapes in the experimental class were that 68% of pupils fell into the category of very high, 20% of pupils were in the category of high, 0% of the pupils were in the middle category, and only 12% of pupils in the low category whilst 0 % of pupils were in the very low category. As for the control class, 48% of pupils fell into the category of very high, 12% of pupils were included in the high category, 24% of pupils were in the middle category, 12% in the low category and 4% were very low. The highest scores in the experimental class and control class were the same, namely 100. The lowest score in the experimental class was 30, whereas in the control class it was 20. The average score for the experimental class was 80.00 whilst for the control class, it was 65.20. Based on the average scores it can be seen that the understanding of the pupils who received the Van Hiele theory based learning was better than the understanding of the pupils who received conventional teaching.

Increased Student Understanding of Simple Shapes

Based on the results of the post-test, it can be seen that pupils' understanding in the classroom experiment is better than the understanding of the pupils in the control class.However, to ensure this, we need to see the improvement that occurred in both classes in test-score gains normalized (N-Gain). The results of the test score gain normalized is presented in Table 4 below:

Table 4

The Calculation N-Gain Score

Group	*N*	*Category Gain*			*Xmin*	*Xmax*	*Overall Average*	*Category*
		High	*Average*	*Low*				
Experimental	25	11 (44 %)	11 (44 %)	3 (12 %)	0.12	1.00	0.67	Average
Control	25	0 %	8 (32 %)	17 (68 %)	0	0.67	0.29	Low

As evidenced in Table 4 above, it can be seen that there was an increase in both classes, but there were vast differences in elevation. From Table 4 it can be seen that there is an understanding in the experimental class with 44% of pupils belonging to the high increase; 44% of pupils classified as moderately increasing their understanding; and 12% of pupils in the group with a low increase. The highest score of N-Gain was 1.00; the lowest score is 0.12; and an average score of 0.67 belonging to a modest increase. As for the control class, there were no pupils who showed a high increase in understanding; 32% of pupils showed a moderate increase; and a 68% of pupils can be classified as having a low increase in their understanding. The highest score was 0.67; the lowest score 0 and the average score 0.29 is classified as being a low increase.

In order to further understand the differences in the normalized gain of average scores, the researcher performed a non parametric test, the Mann-Whitney U test. After this test, the results showed that the pupils who received Van Hiele theory of learning had a greater increase in their understanding that those who didn't.

4. CONCLUSION

The outcomes of this research, processing and analysis of data on the use of Van Hiele based theory of learning simple shapes in the third year of elementary school in Bantarsari Bungursari Tasikmalaya, show the following:

Pupils 'initial understanding of the characteristics of simple shapes in the experimental class and the control class were the same. The learning process based on Van Hiele theory for simple shapes according to Van Hiele's stages of learning included: information stage, the stage of directional orientation, the explanation phase, free orientation stage, and the stage of integration. Learning became more meaningful, because at each stage of learning pupils were exposed to situations that encouraged the pupils to be more active.

Pupils who received Van Hiele based learning had a better understanding of the characteristics of simple shapes than those in the conventional class. The improvements in pupils' understanding of the characteristics of simple shapes was moderate with pupils who received Van Hiele theory based learning whilst in the conventional class it was a lower overall increase.

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