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The effect of the instruction based on Van Hiele model on the geometrical thinking levels of preservice elementary school teachers

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Abstract

The purpose of this study is to determine the effects of the instruction based on Van Hiele Model on preservice teachers' the geometrical thinking levels. This study has been carried out with senior students attending to the Elementary School Teaching Program. There were eight classes of senior preservice teachers, two of them were randomly assigned as experimental groups which were instructed with Van Hiele Model and the other two were randomly assigned as control groups which were instructed with traditional instruction. Based on the analysis of the data, findings will be discussed and some recommendations will be presented.

Keywords: Van hiele model; geometric thinking levels; pre-service elementay school teacher.

1. Introduction

Recently, innovations and changes in the field of mathematics education are particularly reflected on geometry curriculum as well. These innovations and changes in mathematics and geometry are initiated by NCTM. The standards were prepared in 1989 for the first time (Van de Walle, 2004). NCTM, has been the initiator of the recent changes in the field of Mathematics and mathematics teaching through various standards and principles. The learning domain of geometry has been emphasized in NCTM standards and, as a result, geometry and spatial perceptions have been considered as the main elements of mathematics curricula (NCTM, 2000).

NCTM standards which were prepared in 1989 have affected recent geometry programmes carrying the influences of various approaches and models. Van Hiele Model has been taken as the basis for NCTM geometry learning domain standards and the geometry instruction is suggested to be organized according to Van Hiele Model. (Choi-Koh, 2001).

In the light of these developments, through the studies of Instructional Division of Ministry of National Education of Turkey, mathematics curriculum for grades 1 through 5 has been changed in 2004. Mathematics teaching program for grades 1-5 is divided into four learning domains (numbers, measurement, data, and geometry)

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and activities and goals are formed according to these domains (MEB, 2004). When expectations for geometry learning domain in mathematics curriculum is analyzed, it can be stated that it is organized according to Van Hiele's geometrical thinking levels and geometrical concepts are given within the context of this model. At this point, it has become more important for preservice teachers to be trained to establish appropriate instructional settings that is consistent with Van Hiele Model throughout their careers which is accepted as the basis for geometry instruction that goes in accordance with the new program (Pusey, 2003).

1.1. Van Hiele model

Van Hiele Model suggests that geometrical thinking has five closely related stages. Most of the geometrical thinking studies have been carried out by taking this model as the basis. Van Hiele model was formed to improve geometrical comprehension and this model was developed in classroom settings. In this model, students should join the activities and find out the characteristics of geometrical concepts. The most important characteristics of Van Hiele Model is that it explains the development of geometrical thinking process with five related stages. Each of these stages determines the thinking processes that are necessary for finding geometrical relations out. These stages define the process of thinking and the types of geometrical ideas rather than the amount of the data. Geometrical thinking stages proposed by Van Hiele Model are (Olkun ve Toluk; 2003; Van de Walle, 2004): Visual period (Level 0), analytic (Level 1), informal deduction (Level 2), formal deduction (Level 3) and rigor (Level 4). These stages determined by Van Hiele Model explain the geometrical thinking skills of students and they are useful for classroom applications.

1.2. The Purpose of the study

This purpose of this study is to investigate the effects of the Van Hiele Model over traditional instruction on the geometrical thinking skills of the senior preservice elementary school teachers.

2. Method

2.1. Research design

"Pre Test-Post Test Experiment Pattern with Control Groups" was used in this study. Quantitative techniques are also used to analyze the data in detail.

2.2. Study group

The subjects of this study were 142 senior preservice students attending to four classes out of eight classes at the Department of Elementary School Teaching at Abant İzzet Baysal University in Turkey. Two classes were randomly assigned to the experimental group (n=72) while other two group formed the control group (n=70).

2.3. Instrument

In order to address the research questions in this study, students in experimental and control groups were given Van Hiele Geometry Test as pre-post-tests to identify students' geometrical thinking levels. This test was developed by Usiskin (1982). The adaptation into Turkish and reliability-validity of this test was carried out by Duatepe (2001). The reliabilty of Cronbach's alpha of the test was found to be 0,73 in this study.

2.4. Treatment

An instruction consistent with geometrical thinking levels of Van Hiele model was applied to experimental groups whereas traditional method was applied to control groups throughout the study. 14 activities were prepared by researchers and applied to both groups. These activities were prepared for the purpose of teaching geometry topics which were in Primary School Mathematics Curriculum (1-5. grades). These activities were applied to control and experimental groups for 6 weeks totalling to 18 course hours. The activities applied in experimental groups were carried out with a method in which the concepts of discussion, group work, collaborative learning approaches are implemented in a related web in accordance with geometrical thinkng levels of van Hiele whereas, in control groups, the activities were applied with traditional approaches in which the students follow the instruction the teacher gives and the active participations are not promoted. In the control group, students were instructed with traditional instruction which was mainly in lecture format and therefore instruction was teacher centered.

2.5. Analysis of data

In this study, geometrical thinking levels of participants in experimental and control groups before and after the instruction were determined. Data formed in this perspective was analyzed by means of a package program. t-test was used to determine whether there is a significant difference between van Hiele Geometry Test scores of students in experimental and control groups.

3. Findings and Comments

3.1. Findings related to the first sub problem

The first sub problem of this study was as folloes: "Is there a significant difference between van Hiele Test pretest scores of the participants in both groups?". For this sub problem, averages and standard deviation of the prestest scores of van Hiele Geometry Test were calculated. The difference between experimental and control groups van Hiele Geometry Test pretest scores were compared by means of independent t-test. This data is shown in Table 1 for experimental and control groups:

Table 1. T-test Results of Van Hiele Geometry Test Pretest Scores According to the Experimental and Control Groups

	n	*X*	*Ss*	*sd*	*t*	*p*
EXPERIMENTAL	72	7,4306	8,0531	140	0,469	0,640
CONTROL	70	7,7714	7,7863			

As seen in Table 1, the difference between the average scores of control groups' van Hiele Geometry Test and the average scores of experimental groups was compared by means of t-test ($t_{(140)} = 0,469$; $p>.05$) and was not found significant at level $\alpha = .05$. This finding shows that there is no significant difference between control and experimental groups' van Hiele Geometry Test pretest scores.

3.2. Findings Related to the Second Sub Problem

The second sub problem of this study was as follows: "Is there a significant difference between the Van Hiele Geometry Test pretest and post test scores students in the experimental groups statistically?" For this sub problem, van Hiele Geometry Test pretest and post-test averages and standard deviation of the experimental groups which were instructed which take the geometrical thinking levels into consideration were calculated, and the difference between these scores were compared by means of related t-test. This data for experimental groups were shown in Table 2:

Table 2. T-test Results of van Hiele Geometry Test Pretest and Post test Average Scores for Experimental Groups

		n	*x*	*Ss*	*sd*	*T*	*p*
EXPERIMENTAL	*Ön Test*	72	7,4383	4,04143	71	11,381	0,000
	Son Test	72	13,4583	4,58392			

As seen in Table 2, the difference between van Hiele Geometry Test pretest and post-test average scores of the experimental groups was compared by means of related t-test ($t_{(71)}$ = 11,381; p<0.5), and found to be significant at level α =.05. This finding shows that the difference between van Hiele Geometry Test pretest and post test average scores of the experimental groups is significant.

3.3. Finding Related to the Third Sub Problem

The third sub problem of this study was as follows: "Is there a significant difference between the Van Hiele Geoetry Test pretest and post test scores of participants in the control groups statistically?" For this sub problem, van Hiele Geometry Test pretest and post-test averages and standard deviation of the control groups which were instructed using traditional methods were calculated, and the difference between these scores were compared by means of related t-test. This data for control groups were shown in Table 3:

Table 3. T-test Results of van Hiele Geometry Test Pretest and Post test Average Scores for Control Groups

		n	*x*	*Ss*	*sd*	*t*	*p*
CONTROL	*Ön Test*	70	7,7714	4,6068	69	0,450	0,65
	Son Test	70	7,9571	3,7588			

As seen in Table 3, the difference between Van Hiele Geometry Test pretest and post test average scores of participants in the control groups who were taught by means of traditional method was compared by means of t-test ($t_{(69)}$ = 0,450; p>0.5 and found that it is not significant at level α =.05. This finding shows that the difference between Van Hiele Geometry Test pretest and post test average scores of the control groups is not significant.

3.4. Finding Related to the Fourth Sub Problem

The fourth sub problem of this study was as follows: "Is there a significant difference between control and experimental groups Van Hiele Geometry Test post test scores statistically?". For this sub problem, averages and standard deviation of the post-test scores taken from van Hiele Geometry Test were calculated. The difference between experimental and control groups' Van Hiele Geometry Test post-test scores were compared by means of independent t-test. This data is shown in Table 4 for experimental and control groups:

Table 4. T-test Results of Van Hiele Geometry Test Post Test Scores According to the Experimental and Control Groups

	n	*x*	*Ss*	*sd*	*t*	*p*
EXPERIMENTAL	72	13,4583	4,5839	140	7,808	0,000
CONTROL	70	7,9571	3,7588			

As seen in Table 4, the difference between the average post test scores of experimental groups' Van Hiele Geometry Test and the average post-test scores of control groups was compared by means of t-test ($t_{(140)}$ = 7,808; p<.05) and was found to be significant at level α = .05. This finding shows that there is significant difference between control and experimental groups' Van Hiele Geometry Test post test scores.

4. Discussion, Conclusion and Recommendations

The findings of the study showed that the geometrical thinking levels of preservice teachers in both control and experimental groups are close to each other before the instruction. It was seen that the geometrical thinking levels of preservice teachers were low before the instruction when the findings of the study were taken into consideration. This finding is consistent with the research in literature (Ahuja, 1996; Duatepe, 2000; Durmuş, Toluk ve Olkun, 2002; Toluk, Olkun ve Durmuş, 2002). In this study, preservice teachers in experimental groups at the Department of Classroom Teaching were given instruction according to the geometrical thinking levels of Van Hiele. Significant difference was found between the pretest and post test scores of Van Hiele Geometry Test of experimental groups. In other words, it can be claimed that instruction consistent with Van Hiele Model has a positive effect on geometrical thinking levels of preservice teachers. Whereas this finding is consistent with several research (Choi-Koh, 2001; Kılıç, 2003; Lonnie, 2001; Mistretta, 2000; Toluk, Olkun ve Durmuş, 2002; Lalah; 1999), it is not consistent with the result of the study conducted by Durmuş, Toluk and Olkun (2002).

In this study, control groups were taught with traditional method and Van Hiele Geometry Test was applied in order to determine the geometrical thinking levels before and after the instruction as it was applied in experimental groups. When the pretest and post-test scores of Van Hiele Geometry Test of preservice teachers in control group were taken into consideration, it was seen that there was no significant difference between the results. At this point, it can be claimed that instruction given with traditional method did not improve the geometrical thinking levels of preservice teachers. This finding of the study is consistent with the other research (Toluk, Olkun ve Durmuş, 2002; Lalah, 1999). In this study, the geometrical thinking levels of experimental groups which were given instruction according to the Van Hiele levels and of control groups which were given instruction according to the traditional method. In this context, when the post-test results of van Hiele Geometry Test of the participants were examined, a significant difference was found in favour of experimental group. In other words, it was found that the instruction given according to the van Hiele levels was more effective than the traditional method in developing geometrical thinking levels of preservice teachers. This finding of the study is consistent with the literature (Lonnie, 2001; Kılıç, 2003; Toluk, Olkun ve Durmuş, 2002; Lalah, 1999). It can be claimed that the instruction given according to van Hiele levels was effective in developing geometrical thinking levels of preservice teachers. Based on the findings of this study carried out with the preservice teachers enrolled at the Department of Classroom Teaching:, following recommendations for teacher training and further research are given:

1. Geometry and geometry related courses which are given to preservice teachers should be revised in terms of content, scope and conducting and these courses might be reorganized according to the geometrical thinking levels of van Hiele.
2. Geometrical thinking levels of preservice teachers should be determined and instructions should be applied based upon these levels.
3. Courses related to geometry should include applied studies besides theoretical knowledge. Sample activities of teaching-learning process that preservice teachers might face with should be developed and the problems in this process they might encounter should be pointed out
4. Experiences related to geometry and guidance for developing geometrical thinking levels should be provided for preservice teachers.
5. Geometry courses at primary and secondary schools should be revised besides the instruction at teacher training programs and it should be accomplished that the instruction should be supportive and appropriate to the van Hiele geometrical thinking levels.

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