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ANALYSIS OF TEACHING OF VAN HIELE GEOMETRY IN SCHOOLS IN KOREA

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ABSTRACT. In this work we tested van Hiele Geometry tests to 2,413 students from elementary schools, middle schools, and high schools in Korea for year 2015 and 2016. The methodology of van Hiele model was used in questionnaires, and in analysis of data and results. In this work we present the results of the study applied to students in schools in Korea about van Hiele Geometry tests and their analysis. Therefore we determined the distribution of the 5 van Hiele levels of thinking through 12 grades in schools in Korea. Appling this tests to every students through 12 grades in Korean schools, we analyzed 5 van Hiele levels of thinking (Visualization, Analysis, Informal Deduction, Deduction, and Rigor). Later, EXCEL (spreadsheet program) was used in order to analyze the results.
Keywords: Van Hiele, Levels of Thinking, Phases of Learning, Teaching Mathematics, Korea.

RESUMEN. En este trabajo hemos estudiado 2.413 estudiantes de Educación Primaria, Secundaria y Bachillerato en Corea, aplicando un cuestionario de Geometría basado en el Modelo de van Hiele 2015 y 2016. Utilizamos la metodología del modelo de van Hiele tanto los cuestionarios como en el análisis de datos y resultados. Presentamos por tanto los resultados obtenidos del estudio realizado en escuelas con estudiantes de Corea, donde hemos aplicando dicho cuestionario de Geometría basado en el modelo de van Hiele, así como el análisis de los resultados. De este modo, se determinó la distribución de los 5 niveles de razonamiento de van Hiele (Visualización, Análisis, Deducción Informal, Deducción Formal, y Rigor) a través de 12 grados en las escuelas coreanas. Utilizamos EXCEL (hoja de cálculo) para el proceso de la información y el cálculo los resultados.
Palabras clave: Van Hiele, Niveles de pensamiento, Fases de aprendizaje, Matemáticas, Korea.

Introduction

Van Hiele Model

In the 1950's the Van Hieles, a couple of math teachers, formulated the basis for teaching mathematics (geometry) by building their Levels of Thinking which classify mathematics knowledge and the range achieved by students. They proposed their

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teaching methodology based on Learning Phases which would be followed in each of the Levels of Thinking. Van Hiele model basics are completed with the Characteristics of Levels. There are 5 levels in van Hiele model such as level 1 (recognition), level 2 (analysis), level 3 (order), level 4 (deduction), and level 5 (rigor) (cf. Kim's 2015 paper) These levels are used to assess the skills acquired by the students as to classify the curricula knowledge. As Usiskin and other researchers after him did, we shall add the Level 0 (L0) to include those students who have not reached the first of the van Hiele levels. These levels have following properties such as sequential, adjacency, distinction, separation, and advancement. To help students progress from one level to the next, the van Hiele propose a sequence of five Phases of Learning: Inquiry, Directed orientation, Explanation, Free orientation, Integration.

Method

We have determined the distribution of the five van Hiele Levels of Thinking through the six Elementary School courses, three Middle School Courses, and three High School Courses in Korea using the methodology developed by Zalman (1982).

Results

We have determined the distribution of geometric Levels of Thinking obtained from Korean students of Elementary, Middle, High Schools and the statistical analysis of this data. These data provide real assessment of the performance of Korean students in geometry. In May 2015 and 2016 we tested 860 Elementary School students from 2 different schools, 642 Middle School students from 3 different schools, and 911 High School students from 7 different schools in Korea. More specifically, in May 2015, we tested 860 Elementary School students from 2 different schools (Kyunggido A, Seoul B). And we tested 379 Middle school students from 2 different schools (Kyunggido C, Seoul D). Also 263 Middle school students from Kyunggido E Middle school were tested van Hiele Geometry test in May 2016. For the High school students, 572 students from 5 different schools (Kyunggido F, Seoul G, H, I, J) in May 2015 and 339 students from Kyunggido K high school in May 2016.

Usiskin test problems to decide their levels of Thinking we applied to all students of Elementary, Middle, High Schools who were present in them when they did the test, no student was excluded, and all tests have been part of the calculations and analysis.

Levels of Geometric Thinking obtained from Korean school students are shown in Figure 1, where we hold up the percentage distribution (Z axis) of the van Hiele levels per course (X axis) and Levels of Thinking (Y axis). Level L0 stands for students who have not reached the first level of van Hiele (L1), and L1, L2, L3, L4, and L5stand for the five Levels of van Hiele model.

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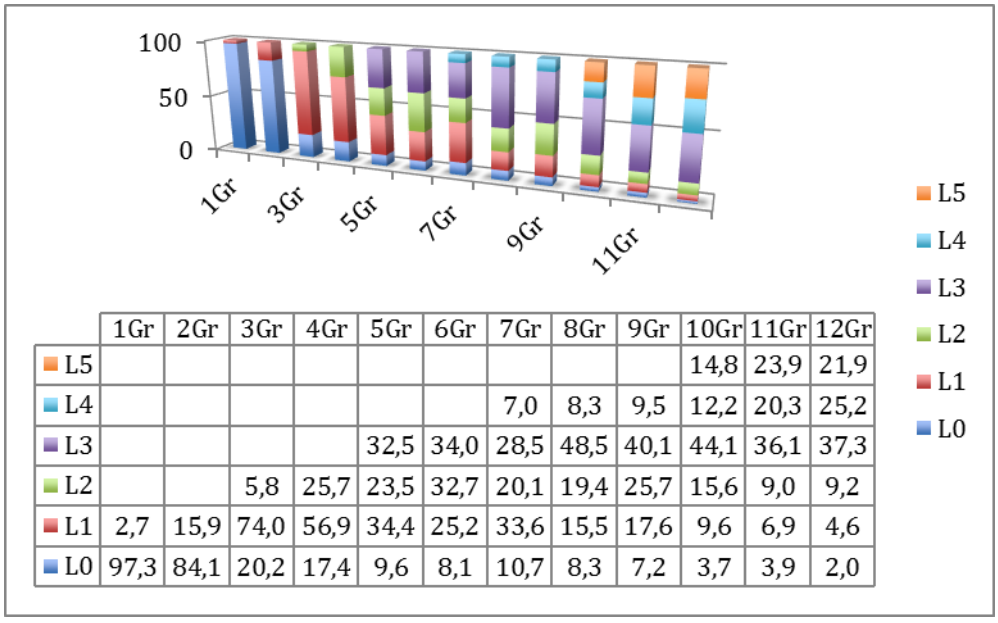

	1Gr	2Gr	3Gr	4Gr	5Gr	6Gr	7Gr	8Gr	9Gr	10Gr	11Gr	12Gr
L5										14,8	23,9	21,9
L4							7,0	8,3	9,5	12,2	20,3	25,2
L3					32,5	34,0	28,5	48,5	40,1	44,1	36,1	37,3
L2			5,8	25,7	23,5	32,7	20,1	19,4	25,7	15,6	9,0	9,2
L1	2,7	15,9	74,0	56,9	34,4	25,2	33,6	15,5	17,6	9,6	6,9	4,6
L0	97,3	84,1	20,2	17,4	9,6	8,1	10,7	8,3	7,2	3,7	3,9	2,0

Figure 1. van Hiele levels of Korean students.

Also, we made question problems about the general attitude concerning mathematics to study the correlation of it with geometry lesson in Korean Middle and High schools. Especially, we made the appropriate teaching plan in accordance with the 5 steps of van Hiele educational method for those who have the lower van Hiele levels than ones required by the 2009 Mathematics Amended Curriculum in Korea, based on the results from the research conducted through the 5 levels of the Van Hiele Model of Geometric Thought. EXCEL was used to analyse the results of the test, the students were classified as the 5 van Hiele levels of thinking and SPSS was used to find relationship between attitude toward mathematics (geometry) and van Hiele level of thinking.

Figure 1 shows the evolution of the acquisition of the van Hiele levels during the six years of Elementary School in Korea. Throughout the elementary grades, Figure 1 shows how L1 and L2 levels grow, while L0 level decreases. Even in 5th year of Elementary School in Korea certain number of students (32.5%) who achieved third level (L3) of van Hiele Thinking appear. And those numbers of students are remained still after 5th grade. Note that we adopt C3 tests according to Usiskin original project in 1982. There are certain numbers of Korean High school students who achieved last level (L5) of van Hiele Thinking. We do not know exact reason how this number of students got highest level (L5). On the other hand, 14.8% of 10th grade Korean students, 23.9% of 11th grade Korean high school students, and 21.9% of 12th grade Korean students achieved level 5 of van Hiele Thinking in Figure 1.

Furthermore, this Figure provide us the criteria to follow in order to analyze the Levels of Geometric Thinking achieved by the students, being positive those profiles where high van Hiele levels of Thinking predominate, and being negative those emphasizing in low levels. Particularly the worst are those featuring a prevalence of level L0 of students who have not achieved the first van Hiele level of thinking. In particular, we use these criteria to compare the levels of Thinking obtained by different

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groups, such as schools, countries, sex, etc. In Figure 2 we obtained the results of van Hiele level of thinking with respect to grade and sex.

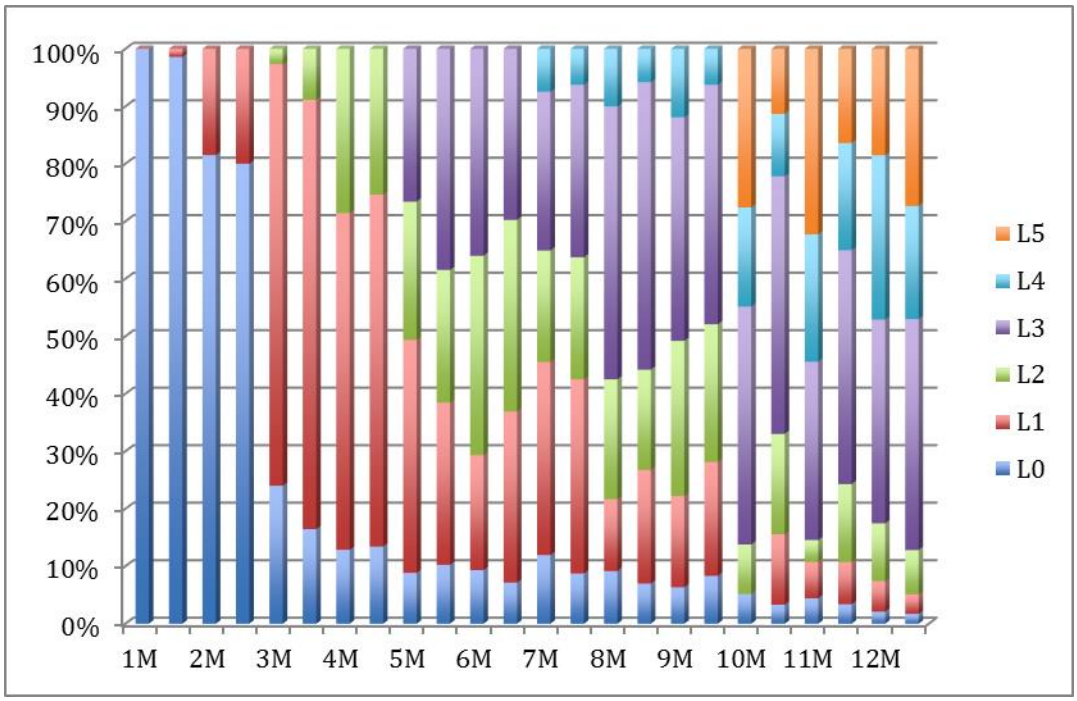
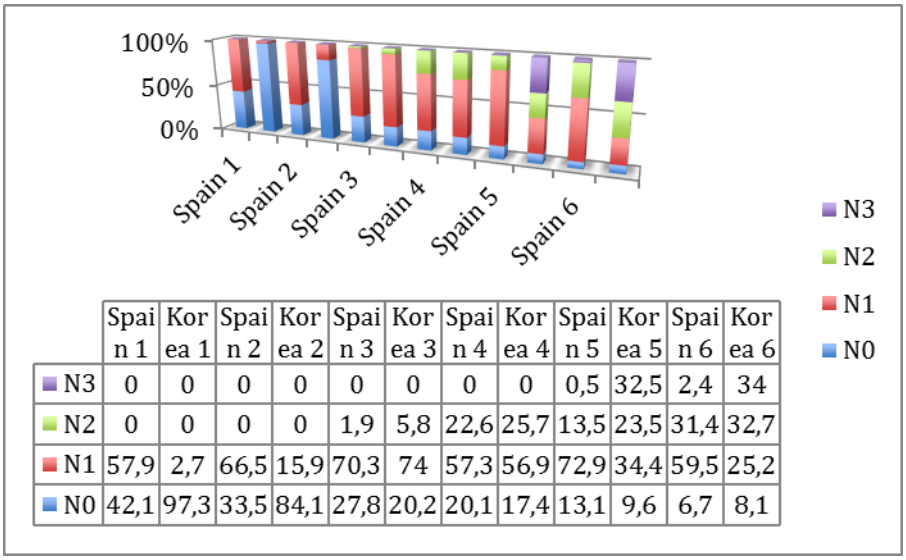


Figure 2. The results of van Hiele level of thinking with respect to grade and sex.

Comparison van Hiele levels of thinking between Spain and other countries

F.J. Ignacio Lopez had comparison results between Spain and other countries like Czech, Malaysia, Nigeria, South Africa. Now we have comparison results between van Hiele levels of thinking for Korea and Spain Primary School Students. The following Figure 3 show the details of those comparison results. 32.5% Korean 5th grade students achieved Level 3, whereas 0.5% Spanish 5th grade students achieved Level 3. Also 32.7% Korean 6th grade students achieved Level 3, whereas 2.4% Spanish 5th grade students achieved Level 3.



	Spain 1	Korea 1	Spain 2	Korea 2	Spain 3	Korea 3	Spain 4	Korea 4	Spain 5	Korea 5	Spain 6	Korea 6
N3	0	0	0	0	0	0	0	0	0,5	32,5	2,4	34
N2	0	0	0	0	1,9	5,8	22,6	25,7	13,5	23,5	31,4	32,7
N1	57,9	2,7	66,5	15,9	70,3	74	57,3	56,9	72,9	34,4	59,5	25,2
N0	42,1	97,3	33,5	84,1	27,8	20,2	20,1	17,4	13,1	9,6	6,7	8,1

Figure 3. van Hiele Levels of Primary School Students in Korea and Spain

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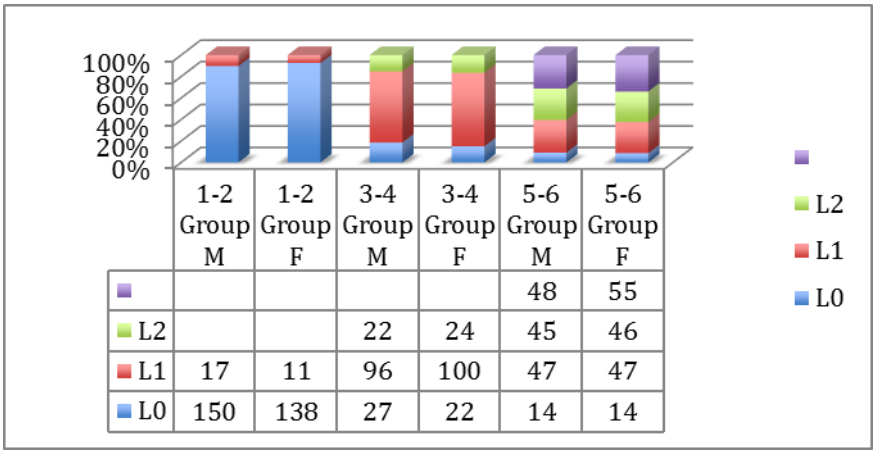
In Figure 4, we obtained detailed results of van Hiele levels of thinking according to Korean elementary school students with respect to sex and circles. We have similar achievements of van Hiele levels of thinking according to sex Korean school students.



	1-2 Group M	1-2 Group F	3-4 Group M	3-4 Group F	5-6 Group M	5-6 Group F
					48	55
L2			22	24	45	46
L1	17	11	96	100	47	47
L0	150	138	27	22	14	14

Figure 4. results of van Hiele levels of thinking for circle students of Korean elementary schools.

Conclusions

The profile of the van Hiele levels of thinking in geometry in Primary or Secondary School is important not only to analyze the performance of Geometry, but also as the basis for an accurate diagnosis of evaluation results and to balance the levels achieved between different groups or countries, (López de Silanes, 2012). We have a comparison results about van Hiele levels of thinking between Korea and Spain for Primary School Students.

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