LEX LOCALIS-JOURNAL OF LOCAL SELF-GOVERNMENT
ISSN:1581-5374 E-ISSN:1855-363X
VOL. 23, NO. S6(2025)

THE VAN HIELE MODEL IN COMPETITION SOLVES PROBLEMS OF SHAPE, MOVEMENT AND LOCATION IN FIRST-GRADE STUDENTS OF SECONDARY EDUCATION OF A STATE EDUCATIONAL INSTITUTION

Rosas Amadeo Amaya Sauceda[1], Jonatan Juan Vera Baca[2], Richard Alex Lopez Albiño[3], Abdias Rafael Esparza Paico[4], Fanny Elvira Castro Castillo[5]

[1]Universidad Nacional de Trujillo,
ORCID 0000- 0002-8638-6834
[2]Universidad Nacional de Trujillo,
ORCID: 0009-0008- 1383-6620
[3]Universidad Nacional, de la Amazonia Peruana
orcid.org/0000-0002-7674-8694
[4]Universidad Nacional de Trujillo
ORCID 0009- 0000-6479-5437
[5]Universidad Nacional de Trujillo,
ORCID 0009- 0004-2571-7283

ramaya@unitru.edu.pe[1]
jverab@unitru.edu.pe[2]
richard.lopez.390@unapiquitos.edu.pe[3]
aesparzap@unitru.edu.pe[4]
P880621024@unitru.edu.pe[5]

ABSTRACT
The main objective of this research entitled The Van Hiele model in competence solves problems of form, movement and location in Secondary Education, had as its main objective to determine to what extent the application of the Van Hiele model improves the competence of first grade students of Secondary Education of a State Educational Institution. The methodology used was of an applied nature, with a quantitative approach and a quasi-experimental design, where the population was made up of 235 students of the first grade of Secondary Education, from which a sample of 64 students was selected: 34 from section A and 30 from section B, to whom an instrument called "Rose and hydrangea seedlings" was applied. which served as a pre- and post-test, which was composed of 18 validated items with an Aiken V coefficient of 1.00 and a reliability with a Cronbach's Alpha coefficient of 0.929. The data were processed and analyzed automatically using the Excel 2019 and SPSS version 26.0 software, obtaining as results that 60% and 40% of the students of the experimental group reached the levels of process and achieved respectively, reaching the conclusion that the Van Hiele model significantly improved the competence to solve problems of form, movement and location, supported by a bilateral significance of -value.$p = 0.0000$

Keywords: Competence, Van Hijale Model, Geometric Reasoning.

ABSTRACT
INTRODUCTION

Geometry is a fundamental part of mathematics, which not only promotes the development of spatial perception, but also allows the exercise of essential cognitive skills aimed at strategic problem solving, such as thinking and creativity. Its importance extends to a wide range of fields, such as science and technological developments, engineering and mathematics itself, establishing itself as a crucial basis for addressing complex challenges in these fields (Bressan and Bogisic, 2000). Under this notion, competence solves problems of form, movement and location, it is what encompasses its study and allows processes such as reasoning, representation and communication to be put into operation; which leads to its great contribution to the integral formation of the individual. However, various studies suggest that many students still face difficulties in developing this geometric competence.

In the international arena, a study conducted by Yaley et al. (2021) in Daffiama Bussie Issade, Ghana, revealed that 75.86% of students face difficulties in understanding, applying, and solving situations related to geometry. In contrast, only 24.14% have a solid foundation in this area, which allows them to correctly address various geometric problems.

The assessment carried out by the PISA test carried out in 2022 shows that, globally, many students struggle with mathematics. Countries such as Singapore and Macau (China) stand out with scores above 550, while Peru's average score was 391 points. Although Peru surpasses nations such as Brazil (379) and Argentina (378), its performance is still lower than that of Chile (412) and Mexico (395). This decline in mathematical performance, especially notable compared to the 400 points achieved in 2018, can be attributed to the impacts caused by COVID-19 and/or teaching methodologies, which affected the development of mathematical skills in various contexts, reflecting a worrying trend. (Organization for Economic Cooperation and Development [OECD], 2023)

At the national level, the most recent report of the Student Sample Assessment (MS) carried out in 2022, reveals a detailed overview of the mathematical performance of students who are in the second grade of secondary education, highlighting that, at the national level, in urban areas, 23.7% of students are at a pre-start level. 38.3% in initiation, 22.9% in process and 15.2% in satisfactory. In contrast, in rural areas, 53.4% are in pre-start, 31.7% in start-up, 10.7% in process and only 4.1% in satisfactory. These data show a notable disparity between urban and rural areas, highlighting a significant gap in academic achievement levels. (Ministry of Education, 2023)

However, the acquisition of geometric skills in students from different geographical contexts in Peru reveals a worrying panorama. In Acobambilla, Huancavelica, Chavarría (2018) identified that 62.1% of the students presented a low acquisition and 37.9% a null acquisition in relation to the levels of geometric reasoning of visualization, analysis and classification of triangles, indicating a significant lack of knowledge in this thematic field. On the other hand, in Lima, the research by Espíritu (2018) recorded that 35% of students were at a Pre-Initiation level and 42.5% at the Beginning level with respect to competence 26.

At the regional level, the results of the 2022 MS in La Libertad reveal a worrying picture. Only 9.5% of the students reached a satisfactory level in mathematics, while 31.8% were in pre-start, 39.4% in the beginning and 19.0% in the process. Unlike 2019, minimal changes are observed, with a decrease of 1.8% in the pre-start level and 5.4% in the satisfactory level, and a slight increase of 5.4% in the start level and 1.8% in the process level. In addition, the results in the Local Educational Management Units (UGEL) of Sánchez Carrión and Santiago de Chuco are particularly alarming, with 48.6% and 51.8% of students at a level prior to starting, respectively. (Ministry of Education, 2023)

As far as the Educational Institution is concerned, students in the first grade of Secondary Education present difficulties in the area of mathematics and its associated competencies. These difficulties are evidenced in the low grades obtained in the evaluations carried out by the teacher, especially in the competence to solve problems of form, movement and location, where a worrying degree of thematic mastery is revealed. This is because students tend to use and memorize formulas without understanding their underlying construction. This lack of understanding limits their strategies for approaching problems in flexible, creative, and critical ways.

The persistent difficulties in education drive the development of theoretical models that structure and organize the interaction between teachers and students, with the aim of guaranteeing optimal results and aligned with social demands. Among these models, Van Hiele's model stands out for its ability to connect different levels of reasoning and facilitate the development of students' abilities to analyze simple concepts and construct more complex ideas. In addition, this model emphasizes the importance of the phases that a teacher must follow to strengthen the student's cognitive skills and optimize the teaching-learning process. (Corberán, 2014)

Problem statement To what extent does the application of the Van Hiele model improve competence solve problems of shape, movement and location in first-grade students of Secondary Education of the State Educational Institution?

General objective To determine to what extent the application of the Van Hiele model improves competence and solves problems of shape, movement and location in students of the first grade of Secondary Education of the State Educational Institution

Specific objectives To identify the levels of competence that solves problems of shape, movement and location, in their dimensions, in students of the first grade of Secondary Education of the State Educational Institution, before the application of the model.

Applying learning sessions using the Van Hiele model to improve competence solves problems of shape, movement and location in first-grade students of Secondary Education of the State Educational Institution.

Evaluating the levels of competence solves problems of shape, movement and location, in their dimensions, in students of the first grade of Secondary Education of the State Educational Institution, after the application of the model.

Hypothesis

H_1: The application of the Van Hiele model significantly improves competence and solves problems of shape, movement and location in first-grade students of Secondary Education of the State Educational Institution.

H_0: The application of the Van Hiele model does not significantly improve competence and solves problems of shape, movement and location in first-grade students of Secondary Education of the State Educational Institution

Definition of the Van Hiele model

According to researchers Jaime and Gutiérrez (1990), the Van Hiele model is a structured sequence that allows for pleasant communication between teacher and student, with the aim of introducing students to mathematical concepts and theories in an appropriate way that fosters a deep understanding, accompanied by a high level of reasoning through a series of phases or stages.

On the other hand, Fuys et al. (1988) state that the model is a feasible structure that allows addressing the problems present when teaching or teaching geometry classes, such as difficulties in defining, recognizing or relating geometric shapes based on their properties; which the Van Hiele called these behaviors and actions as levels of geometric maturity of the student.

These levels of maturity were studied by Pierre Van Hiele, who formulated a theoretical structure of the levels of thought and principles designed to help students understand geometry, while Dina Van Hiele-Geldof focused on applying Pierre's theory through a didactic experiment aimed at enriching the degree of geometric reasoning of her students through suggested actions for teachers. which I call phases of learning.

Levels of reasoning of the Van Hiele model

The levels of geometric maturity are clearly represented and theoretically argued by the Van Hieles in their model, who establish five levels of development. According to the description made by Burger & Shaughnessy (1986), the levels are characterized as follows:

a) Level 0: Visualization

The form of geometric reasoning of the students under this level of visualization is both physical and global. This level involves thinking of basic geometric concepts as simple shapes, employing visual considerations that encompass the concept in its entirety, i.e., students understand and assimilate geometric figures holistically, without explicitly stopping to analyze the individual properties of their components. In the same way, at this level, the student should become familiar with geometric language, using simple terms to describe the shapes he observes.

These descriptions or properties that are verbalized through this level usually refer to real objects or characteristics that resemble the geometric figure that is to be described. It is common to hear expressions such as "it is longer than it is wide" or "it looks like a door"; This is because the reasoning used is global and students do not yet explicitly use the mathematical elements that make up the concept, which prevents them from discovering, using and analyzing the properties and elements that strengthen the concept, so their arguments are limited to describing the concepts or properties as concrete and observable objects.

b) Level 1: Analysis

At this level, the student is aware of the existence of components and properties of geometric concepts, which leads to the need to acquire meticulous observation and critical reflection. With these skills, the student will be able to discover the properties that the elements possess and work with them to solve problems, justify their conclusions, and even allow them to gain a broad view of the concept, allowing them to construct geometric figures and identify their elements, such as sides, angles, and vertices. In this way, the student can describe the geometric concept with a broader and more specific vocabulary.

These new descriptions that students verbalize tend to be redundant lists of characteristics or properties of concepts. This is due to the absence of logical reasoning that allows identifying the interrelationships between the different elements or properties, so their arguments are based on the exploration of concrete examples that verify the aforementioned properties.

c) Level 2: Abstraction

Advancement to this level occurs when the student discovers the existence of logical relationships and connections between the properties of the concept, using them to formulate deductive arguments. This implies that the learner can identify, group and logically order a list of properties related to the concept, such as grouping figures based on their common properties, in order to make logical inferences about these relationships and construct abstract definitions.

Likewise, at this level, the aim is to determine the sufficiency and suitability of a set of properties when establishing a concept. This means strengthening definitions, transforming the lists of properties described in level 1 into simple minimum sets with sufficient and necessary conditions to establish deductive relationships and generalize concepts; opening the way to a deeper understanding of the hierarchy and classification of geometric concepts that allow much more sophisticated arguments, using symbolism and logical reasoning.

d) Level 3: Deduction

The level of deduction is developed based on formal mathematical reasoning. Students who manage to achieve this level of reasoning are able to string together the implications in a complex way and understand the structure of axiomatic systems, including their main elements such as postulates, definitions, and theorems. In addition, they understand and make use of formal mathematical language for the purpose of deciphering and constructing formal geometric demonstrations; as well as making use of axiomatic systems and their definitions, postulates, theorems, etc. to reason deductively and justify their statements and/or demonstrations.

e) Level 4: Rigor

It is the most advanced level of geometric understanding, whose main characteristic is the ability to perceive geometry "from the outside" and recognize the existence of various axiomatic systems that originate different types of geometries, with the absence of concrete models, such as analytical, hyperbolic, elliptical, Riemannian geometry, among others. Students under this level can compare different axiomatic systems, analyzing specific or complex properties; for example, analyze how the sum of angular measurements behaves in a triangle in planar, elliptical or hyperbolic geometry.

The levels of reasoning described from 0 to 4 allow us to understand how a student thinks or reasons from such simple concepts to understanding other more complex ones. As Jaime and Gutiérrez (1998) state, the levels are independent and are not linked to a specific age of the students. Not depending on age, it is clear that some students may not even make it past the second level, while others will reach the third level at the age of 14 or 15. However, level 4 will generally be out of reach for secondary school students due to the limitations imposed by state guidelines, although those students who manage to reach this level can carry out small simple explorations under the guidance of the teacher; therefore, instruction and personal experience are more important factors in the development of reasoning than the age of maturity itself.

Competence solves problems of shape, movement and location

Definition

According to Minedu (2016), this competence consists of students developing and exploring their skills that are aimed at locating themselves in space, describing objects and geometric shapes, as well as translating reality through graphics and geometric language.

Troubleshooting

A problem is a challenging situation that drives the subject to put his or her knowledge into play in order to question and modify it in order to generate new knowledge; as well as to develop his affective mobility of the intellect, his active behavior and the satisfaction of discovery (Azinián, 2000). In essence, a problem is conceived as a challenging situation that requires the individual to put into practice his or her cognitive activity to formulate strategies or propose solutions for resolution.

Problems, being challenging situations, become the basis of meaningful and comprehensive learning. This is evidenced by the problem-solving process, where the need arises to know, explore and understand various concepts, theories and formulas that allow us to approach possible solutions; thus falling into deeper and more lasting learning that prepares students to face challenges in real life.

Problems may vary in their level of complexity, but each and every one of them demands the skill and ability of the individual to know how to choose wisely and apply the best formulas, theorems and concepts in order to find effective solutions. These actions that allow solving problems with unique and creative solutions are called competencies and capabilities.

METHODOLOGY

The research was of an applied type. Following the perspective outlined by Baena (2017), applied research is focused on the practical translation of general theories aimed at generating concrete solutions to the needs that emerge in society and among people. In this sense, the research focuses on the practical application of Van Hiele's model theory in proposing solutions to the challenges faced by students and society in general in the field of geometric competence.

The research approach was a quantitative approach, as it follows a rigorous and structured process focused on data analysis and collection to generate answers to research questions and verify the hypotheses formulated. In addition, it allows precise measurements of variables and instruments, making use of descriptive and inferential statistics to establish patterns of behavior from which conclusions will be drawn. (Ñaupas et al., 2018)

The research was developed under a quasi-experimental design, which involved working with two equivalent comparison groups through interrupted time series through a before and after evaluation of the intervention in a control group and an experimental group (Bernal, 2010). The design adopted is structured following the scheme described below.

$$\text{GE: } O_1 \cdots\cdots\; x \;\cdots\cdots\; O_2$$
$$\text{GC: } O_3 \cdots\cdots\cdots\cdots\cdots\cdots\; O_4$$

Where:

- GE: Experimental group, composed of 30 students from section B of the first grade of Secondary Education.
- GC: Control group, composed of 34 students from section A of the first grade of Secondary Education.
- O_1 and: Pre-Test results corresponding to the EG and GC.O_3
- O_2 and: Post Test results corresponding to the EG and GC.O_4
- x: Application of the learning sessions using the Van Hijale Model.

Population

Martínez (2012) argues that the population is a set of elements, whether people, objects or things, that share certain similar and distinctive characteristics; about which inferences are to be made from a sample extracted from it.

The population was composed of all students in the first grade of secondary education, enrolled, distributed according to the enrollment lists detailed below.

Sample

According to Hernández and Mendoza (2018), a sample is a carefully selected subset of a population of interest, from which pertinent data are collected to generate results and extrapolate to the general population.

The sample was made up of 64 students of the first grade of Secondary Education belonging to sections A and B,

The sampling used was non-probabilistic convenience sampling, in which the sample was chosen according to the convenience and consideration of the researcher, allowing him to arbitrarily select the appropriate and relevant number of participants for the study. (Niño, 2021)

Data collection tools

The technique used for data collection was evaluation, which is a research technique that allows acquiring information on the cognitive skills, such as knowledge, understanding, and problem-solving ability, of a study subject. (Medina et al., 2023)

The instrument for collecting information from the sample was an objective test. According to Arias (2020), the objective test is an instrument that allows the evaluation of the level of learning achieved by a subject in a certain topic, through items or questions aligned with the research objectives, which makes it easier for the researcher to demonstrate both the logic and the knowledge of the subject under study.

The objective test used in the research was designed by the researcher, under the name of "Rose and hydrangea seedlings". This objective test consists of 18 items focused on assessing competence 26 through four dimensions:

- D1. Model objects with geometric shapes and their transformations: 4 items
- D2. Communicates their understanding of geometric shapes and relationships: 5 items,
- D3. Use strategies and procedures to orient yourself in space: 5 items
- D4. Argue statements about geometric relationships: 4 items.

Each item was assessed according to the depth of the response and its level of reasoning in an interval from 0 to 5 and, for the interpretation of the results, three different levels were adopted, which are: Low, Medium and High. These three levels and their intervals were carefully defined and organized in Table 3, which provides a comprehensive understanding of how the data were organized.

Validity

Validity, as Ríos (2017) argues, is the degree to which an instrument effectively measures the variable it proposes to measure, in accordance with the established objectives. In this sense, validity considers the adequacy of the instrument according to the study in question.

In this research, the validity of the instrument was determined through the judgment of three experts and specialists in the area of mathematics, who evaluated four aspects in each item using a dichotomous scale: sufficiency, coherence, relevance and clarity. After calculating Aiken's V coefficient, a value of 1.00 was obtained, which confirms the validity and applicability of the instrument.

Reliability

According to Ñaupas et al. (2018), reliability is the degree of consistency that an instrument has, that is, an instrument is classified as reliable when the measurements obtained are consistent and do not present significant variations, either over time or when applied to different groups of people or research subjects whose characteristics are similar to the sample or study population.

According to Table 4, the reliability of the instrument was determined using Cronbach's Alpha coefficient, with a pilot test carried out on 30 students with traits similar to the study group, where the coefficient obtained was 0.925, indicating an "excellent" reliability according to the levels established in the scale of George & Mallery (2003). This demonstrates the suitability of the instrument for application in the study sample.

Data processing and analysis techniques

Data analysis was performed using both descriptive and inferential statistical techniques. Descriptive statistics comprises a set of methods that focus on summarizing and describing data through tables, graphs, and analytical calculations. Inferential statistics, on the other hand, encompasses a set of techniques used to make generalizations or inferences about a population, based on data collected from a representative sample. These inferences can be subject to a margin of error, so it is crucial to establish the reliability of inferences using probability. (Córdova, 2003)

In line with the statistical techniques, the data were collected by applying the instrument to the selected sample. Subsequently, the processing and analysis of the data was carried out in an automated way, using Excel 2019 and SPSS version 26.0 software. These tools allowed the presentation of the results using statistical tables and graphs, offering a clear and detailed visualization of the findings obtained. Finally, to evaluate the effectiveness of the applied program and determine if significant improvements were observed in the students, a normality test was performed that provided the basis for the testing of hypotheses through the execution of the Student's T-test for both independent and paired samples. In this way, a rigorous evaluation of the effects of the program could be carried out, supporting the findings with robust and reliable statistical analyses.

RESULTS

Table 1

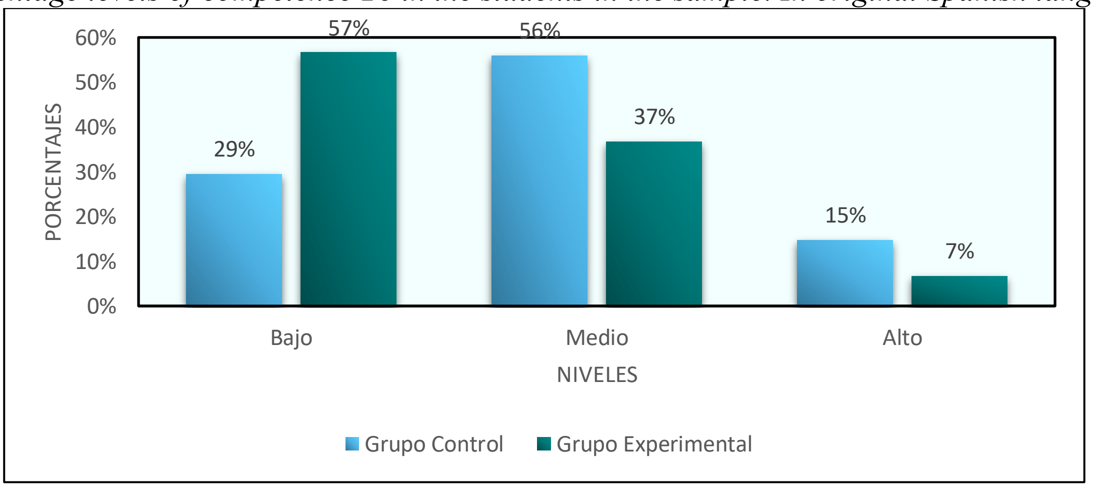
Levels of competence 26 in the students in the sample.

Levels	Control Group		Experimental Group	
	fi	*%*	*fi*	*%*
Low	10	29%	17	57%
Middle	19	56%	11	37%
High	5	15%	2	7%
TOTAL	34	100%	30	100%

Note. Data collected after the application of the instrument as a Pre-Test.

Figure 1

Percentage levels of competence 26 in the students in the sample. In original Spanish language



Source: Table 1

Table 1 and Figure 1 show the findings prior to the implementation of the Van Hiele model, in which it is observed that in the control group, 29% of the students are at a low level, 56% at a medium level and only 15% at a high level. In contrast, in the experimental group, only 7% reached a high level, 37% a medium level and a remarkable 57% were located at a low level. These figures provide evidence to support difficulties in study competence in both groups.

Table 2

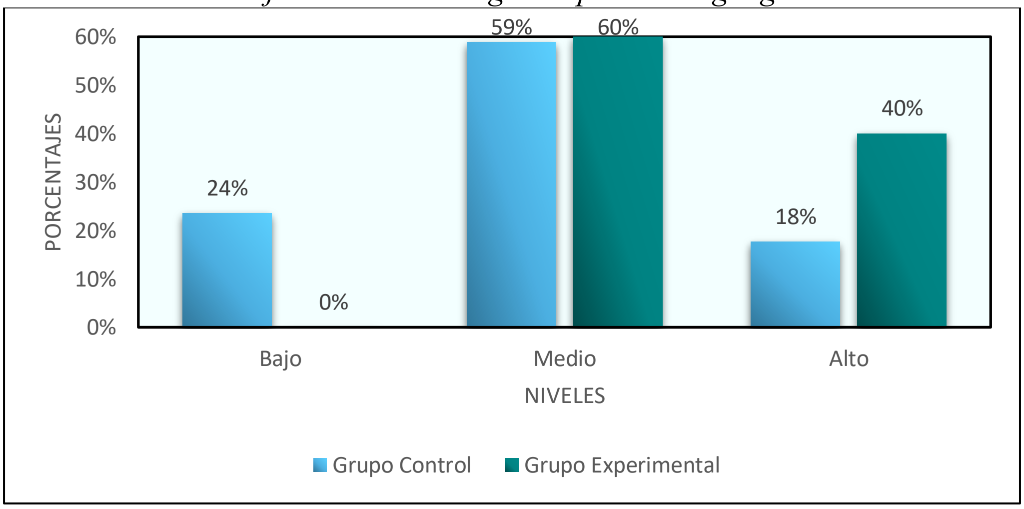
Levels of competence 26 in the students in the sample, after the application of the Van Hijale model.

Levels	Control Group		Experimental Group	
	fi	%	*fi*	%
Low	8	24%	0	0%
Middle	20	59%	18	60%
High	6	18%	12	40%
TOTAL	34	100%	30	100%

Note. Data collected after the application of the instrument as Post-Test.

Figure 2

Percentage levels of competence 26 in the students in the sample, after the application of the Van Hijale model. In original Spanish language



Fountain. Table 2.

Table 2 and Figure 2 provide the data acquired after the application of the Van Hiele model. In these results, it is observed that 24% of the members of the control group are at a low level, 59% at a medium level and 18% reached the high level. On the other hand, in the experimental group, 60% reached the medium level, 40% the high level and no student is at a low level. This shows and supports that the model used generates an improvement in study competence.

Table 3

Levels of competence 26 in the students in the sample, before and after the application of the Van Hijale model.

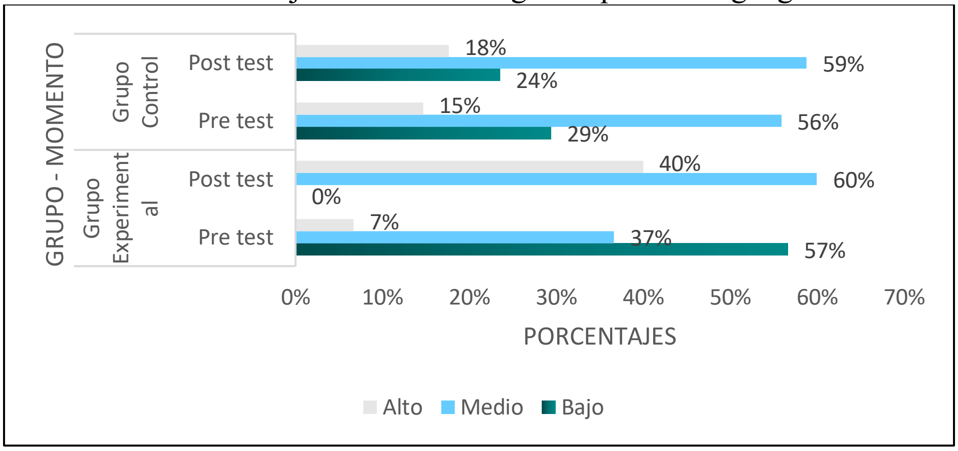
Level	Experimental Group		Control Group	
	Pre-test	Post test	Pre-test	Post test

	fi	%	*fi*	%	*fi*	%	*fi*	%
Low	17	57%	0	0%	10	29%	8	24%
Middle	11	37%	18	60%	19	56%	20	59%
High	2	7%	12	40%	5	15%	6	18%
TOTAL	30	100%	30	100%	34	100%	34	100%

Note. Data collected after applications of the instrument.

Figure 3

Percentage levels of competence 26 in the students in the sample, before and after the application of the Van Hijale model. In original Spanish language



Fountain. Table 3.

According to the data presented in Table 3 and Figure 3 referring to the levels of competence, it can be noted that, in the experimental group, initially, 57% were at a low level, 37% at a medium level and 7% at a high level. However, after the implementation of the model, a remarkable 40% and 60% reached the high and medium levels respectively, and no learner is at the low level. In contrast to the control group, the 29% who were at a low level dropped to 24%, while 56% at the medium level increased to 59%. In addition, the 15% who were at a high level, increased to 18%.

Normality test

The normality test used was the Shapiro-Wilk test, which is a statistical test used to analyze whether a series of less than 50 data has a normal distribution (Córdova Zamora, 2006). According to our research, the sample meets the requirements for use. So we put forward the hypotheses:

- H_0: The data sample follows a normal distribution.
- H_1: The data sample does not follow a normal distribution.

Decision criteria:

- If -value is rejected $p < 0.05 H_0$
- If -value is accepted $p \geq 0.05 H_0$

Table 4

Normality test of the pre-test and post-test, of the experimental group.

	Shapiro-Wilk		
	Statistical	Gl.	Gis.
Pre-test	.937	30	.075
Post test	.904	30	.094

Note. The data shown were acquired using the SPSS software version 26.0.

According to Table 4, the Shapiro-Wilk test reveals that in the pre-test, the value of , so it is accepted, which indicates that the data have a normal distribution. On the other hand, in the post-test, the value of , which leads to accepting . Based on these results, it is concluded that the scores obtained by the students in the two moments of the research are normally distributed. Therefore, a parametric test was used to test the hypothesis.$p = 0.075 > 0.05 H_0 p = 0.094 > 0.05 H_0$

Student's t-test for independent samples

The evaluation and comparison analysis in the experimental and control group, both at the beginning and at the end of the application of the model, was determined by means of the parametric Student's T test, posing the hypotheses:

- $H_0: \mu_c - \mu_e = 0$
- $H_1: \mu_c - \mu_e \neq 0$

Decision criteria

- If -value is accepted.$p < 0.05 H_1$
- If -value is rejected.$p \geq 0.05 H_1$

Table 5

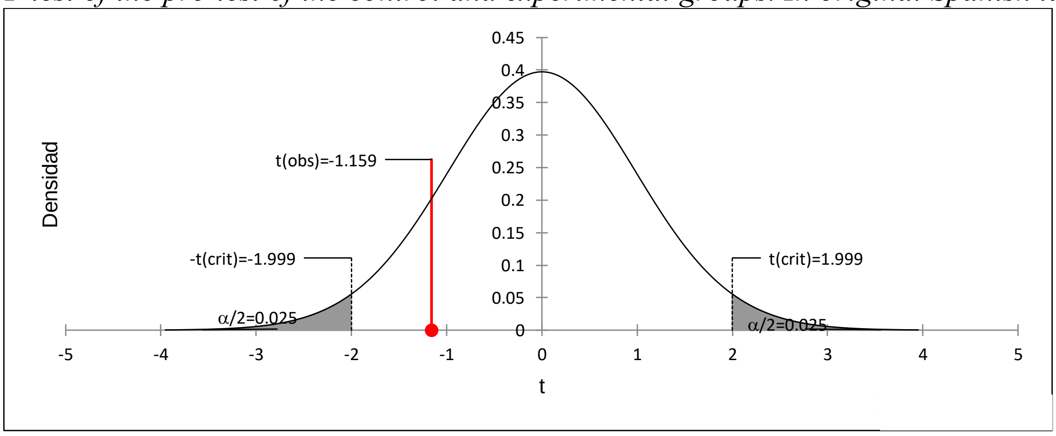
Pre- and post-test student T-test of the control and experimental groups.

	D	*t*	Gl	Sig. (Bilateral)	Critical Value *t*	95% CI	
						Inferior	Superior
Pre Test	-10.019	-1.159	62	.251	$\pm$1.999	-11.714	3.118
Post Test	16.960	3.141	62	.003	$\pm$1.999	4.163	18.739

Note. The data shown were obtained using SPSS version 26.0 software.

Figure 4

Student T-test of the pre-test of the control and experimental groups. In original Spanish language



Note. The graph shows the t-bilateral test of the Pre Test, obtained by XLSTAT.

From table 5, it is evident that the -value , so it is rejected. In addition, from Figure 4, it can be seen that (obs) is within the acceptance zone of ; which allows us to conclude that there is no statistically significant difference between the two groups before the application of the model.$p = 0.251 > 0.05 H_1 t = -1.159 H_0$

DISCUSSION

Regarding the general objective, the results obtained by the Student's t-test with a confidence level of 95% and a significance level of 5%, was a calculated t-value of 17.412 with a bilateral significance of 0.0000, which allowed us to affirm that the Van Hiele model effectively improved competence 26.The results found, agree with the findings of Pujawan et al. (2020) who, using a similar sample of 64 learners divided into two groups of equal size, were able to determine using a right-tail Student T-value that spatial skills related to platonic solids were much better developed in students who were taught using the Van Hijale model, compared to those who followed conventional learning. Similarly, Yaley et al. (2021) recorded significant improvements, supported by a T-Student value of 4,257 and a difference in the averages of 18,844 points in favor of the experimental group, which allowed ratifying the influence of Van Hiele's teaching approach, by highlighting the difference observed in the members of the experimental group who demonstrated continuous efforts to perform tasks strategically and provide logical arguments in each presentation. In the same way, $t = 3.890$Chavarría (2018) in his research in a single study group, determined a considerable improvement supported by a T-Student value of ; leading to reaffirm that the model applied contributed greatly to the progress of the competition $26.-15.632$

In line with these findings, the implementation of the Van Hiele model in students between the ages of 11 and 13 produced results in accordance with the theoretical foundation proposed by Jaime and Gutiérrez (1998) and reaffirmed by Corberán (2014). Both authors argue that advances in geometric thinking do not depend directly on the age of the students; corroborating this theory through the development of research, where an average of 52.8% of the students addressed complex situations, solved problems and exercises, and substantiated their solutions using sets of geometric symbols and an adequate level of reasoning. |

In relation to the first specific objective, it was identified that the average level of the students in the experimental group in competition 26 was a low level, evidenced by an average of 29,113 and 57% of them at that level. On the other hand, 47% of the students presented a low level both in dimension 1 of modeling objects with geometric shapes and their transformations, and in dimension 2 of using strategies and procedures to orient themselves in space. Regarding dimension 3 of communicating their understanding of geometric shapes and relationships, 50% of the students presented a low level, while in dimension 4 of arguing statements about geometric relationships, 67% were also at a low level.

An equivalent result was presented by Espíritu (2018) where in research, through the pretest, he identified a pre-start level with a remarkable 41.7% of the members of the experimental group at this level; Likewise, 37.5% were in the beginning, 4.3% in the process and only 16.7% were in the process of being achieved. For his part, Ybañez (2022) identified a medium level with respect to competence 26 in his pre-test, where 73% of the students in the experimental group were at that level, 30% at a low level and only 7% achieved a high level; In addition, it identified the same average level in each of the dimensions of competence 26, with 63% standing out at this level with respect to dimension 1, 67% in both dimension 2 and dimension 3, and 53% in dimension 4.

With regard to the second specific objective, 10 learning sessions based on Van Hiele's model were carried out to strengthen competence 26, resulting in significant improvements. It was observed that 40% of the students who were part of the experimental group reached the level achieved, while 35% obtained an outstanding level. In addition, these improvements were not only in general competence, but also in each dimension argued with a bilateral significance of 0.000 in each dimension using the Student T test.

Similarly, Espíritu (2018) developed 9 sessions with 8 fundamental practices guided by the phases of the Van Hijale model, as did Ybañez (2020), who implemented 12 sessions that corroborated the benefits of the model. It is important to note that the application of the sessions is aligned with the requirements of Minedu (2016), which argues that competence 26 and its capacities should serve as a comprehensive resource that allows students to function competently in their environment, reasoning about their actions and anticipating possible results or strategic solutions to the problematic situations that arise.

Regarding the third specific objective, after the application of the Van Hiele model, a change of level in competence 26 was evaluated, reaching an average level with an average of 58,906 points and 60% of the students positioned at that level. On the other hand, in its dimensions, in a similar way, a high level was reached with 63% in dimension 1, 57% in dimension 2 and 50% in dimension 3, while dimension 4 presented a medium level with 50% of students at this level.

In relation to this, Ybañez (2022) also identified significant improvements similar to the research, highlighting that 63% of the students reached an average level with respect to the dimension models objects with geometric shapes and their transformations, a considerable 67% reached the same level both in the dimension communicates their understanding of geometric shapes and relationships and in the dimension uses strategies and procedures to orient themselves in space. In addition, 63% reached the high level in the dimension argues statements about geometric relationships; validating these improvements with T-Student statistical values of a queue with similar significance (-value) in each dimension.$p = .000$

CONCLUSIONS

1. It was determined that the application of the Van Hiele model significantly improved the competence to solve problems of shape, movement and location in first-grade students of Secondary Education of I.E. No. 81014 Pedro Mercedes Ureña, Trujillo – 2023, with a bilateral significance of 0.0000; confirming the veracity of the hypothesis that the application of the Van Hiele model leads to a significant improvement in competence 26.
2. A low level of competence was identified in solving problems of shape, movement and location, prior to the application of the model in the students of the experimental group, who presented an average of 29,113 and 57% of them were at a low level. Likewise, a low level was identified in each of the dimensions, where low level percentages of 47%, 50%, 47% and 67% respectively were evidenced in each dimension.
3. The application of the learning sessions using the Van Hiele model, improved by 40% the level achieved of competence solves problems of shape, movement and location, in the first grade students of Secondary Education of the I.E. N° 81014 Pedro Mercedes Ureña, Trujillo – 2023, belonging to the experimental group. Likewise, improvements were observed in each dimension argued by similar bilateral significances of 0.000.
4. It was evaluated that the level of competence solves problems of shape, movement and location, after the application of the model, it was an average level with an average of 58,906 and 60% of the students of the experimental group at that level. In addition, a high level was identified in each dimension, where percentages at a high level of 63%, 57% and 50% respectively were evidenced in dimensions 1, 2 and 3, and a medium level with 40% in dimension 4.

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