EDUKASI
Published by:
Faculty of Teacher Training and Education,
Universitas Khairun

e-ISSN 2715-8551

DOI: http://dx.doi.org/10.33387/j.edu.v24i1.11949
https://ejournal.unkhair.ac.id/index.php/edu
(Accredited Sinta Rank 3)

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Gestures of Junior High School Students Based on Van Hiele Levels of Thinking

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ARTICLE INFO

Keywords:
Gestures;
Geometry;
Van Hiele level's of thinking

Article history:
Received 2026-05-02
Revised 2026-05-22
Accepted 2026-05-30

ABSTRACT

The aim of the research is to describe the pointing gestures, representational gestures and writing gestures of students of SMP Negeri 1 Kota Ternate based on Van Hiele level's of thinking. This research uses a case study. The subjects of this research are 2 students of SMP Negeri 1 Kota Ternate and 2 students have gone through the subject selection levels. The researcher was the main instrument and recording tool, the VHGT question sheet and interview guide as supporting instruments. The data collection procedure was carried out by recording students while completing the VHGT, interviews and recording the details of students' answers using a handycam/android phone. Qualitative data analysis was carried out exploratively and continuously until complete or no new data was obtained about students' gestures based on Van Hiele level's of thinking. Students used pointing gestures at Van Hiele level's of thinking 0, 1 and 2 to focus attention on certain visual objects or geometric shapes, focus attention on objects related to the properties of the shapes, and focus attention on objects related to the properties of geometric shapes and connect them with the properties of other geometric shapes. Students used representational gestures at Van Hiele level's of thinking 0, 1 and 2 to describe or visualize geometric shapes concretely, describe or simulate the properties or rules that fulfill geometric shapes, and describe or simulate the properties or rules that fulfill geometric shapes. Students use their respective writing gestures at Van Hiele level's of thinking 0, 1 and 2 based on the visual characteristics or appearance of geometric shapes, when writing relationships in a geometric shape and to understand the relationship between one geometric shape and another.

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INTRODUCTION

Students should easily obtain solutions to mathematical problems using geometric imagery (Ruhama, 2024; Wicaksono et al., 2021). Learning geometry facilitates students in learning various topics in mathematics and other sciences (Bada, 2024; Casanova et al., 2021; Nu'man & Azka, 2023; Sulistiowati et al., 2019). This is because geometry material focuses on objects, definitions, symbols, and images that can be used as sources of concrete ideas or concepts by students (Sukmawati & Salsabila, 2017). Ideally, students are also expected to be able to actively use a variety of gestures, including pointing, representational, and writing, when solving mathematical problems (Ruhama, 2024). The use of these varied gestures is crucial for explaining material, communicating ideas, and facilitating students' understanding of the material presented by other students in classroom interactions (Lorenza & Imauddin, 2023).

However, in reality, this ideal situation contrasts with the objective reality in schools. Junior high school students in Ternate still experience significant difficulties in learning geometry (Nursyam, 2016; Rusli & Nani, 2021). The primary factor contributing to students' difficulties with geometry is their suboptimal thinking skills.(Hafizh & Kusno, 2025; Mulbar et al., 2026; Sulistiowati, 2022). More specifically, the most common real obstacle encountered in the field is students' inability to visually imagine the given geometry problems (Hafizh & Kusno, 2025; Sulistiowati, 2022). Due to these visualization barriers, the potential of geometry as a problem-solving medium cannot be utilized optimally by junior high school students in Ternate.

To bridge this gap, the use of gestures (finger movements or writing tools) is a crucial solution to reduce students' cognitive load in geometry (Alibali & Nathan, 2007; Mulbar et al., 2026; Sagita & Hendriana, 2021). The use of gestures has been proven to help overcome student difficulties (Sagita & Hendriana, 2021) while simultaneously reducing cognitive load in geometry (Mulbar et al., 2026). Operationally, students' visualization barriers can be overcome by classifying three gestures: pointing gesture to focus on mathematical objects or ideas, representational gestures to visualize abstract objects or ideas in the air, and writing gestures which functions to leave a permanent mark on paper or screen (Alibali & Nathan, 2007; Ruhama et al., 2018).

Research on student gestures in solving geometry problems has been examined by Sagita & Hendriana (2021). Sagita & Hendriana found that students use pointing gestures, representational gestures, and writing in solving geometry problems. However, this research was conducted in a general manner and was not based on Van Hiele level's of thinking. On the other hand, research on student gestures based on Van Hiele level's of thinking has been conducted by Masita et al. (2016) and Mulbar et al. (2026). Masita et al. (2016) found that pointing and representational gestures are gestures that correspond to Van Hiele level's of

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thinking 0 (visualization) and Van Hiele 1 (analysis) in solving geometry problems. Furthermore, Mulbar et al. (2026) expanded on these findings and found that students use pointing and representational gestures at Van Hiele level's of thinking 0 (visualization), Van Hiele 1 (analysis), and Van Hiele 2 (informal/formal deduction) when solving geometry problems. Although Masita et al (2016) and Mulbar et al (2026) have studied students' gestures at the Van Hiele levels, these studies have not yet examined students' writing gestures.Variations of pointing gestures, representational gestures, and writing can be displayed by students in solving geometry problems at the Van Hiele thinking levels. Therefore, the purpose of this study is to describe the pointing gestures, representational gestures, and writing gestures of students of SMP Negeri 1 Kota Ternate based on the Van Hiele thinking levels.

RESEARCH METHODS

The type of research used was a case study. This type of research was chosen because it allows researchers to explore a case involving one or more individuals from one or more specific research locations. In this research, the case study aimed to describe the gestures of students at SMP Negeri 1 Ternate City based on Van Hiele level's of thinking.

The subjects in this study were 2 students from SMP Negeri 1 Ternate City. The subject selection process was as follows: 1) Students who had been taught the material on quadrilaterals and triangles, 2) Students who were willing to volunteer to be research subjects (*willingness*), the decision to become a research subject without any coercion or pressure from outside, such as the school or teachers, 3) students have good interpersonal communication skills so that they help researchers in collecting data, 4) students can do it correctly at least 3 from 5 question *Van Hiele Geometry Test* (VHGT) which is given in each sub-test of the Van Hiele thinking levels and the student is at the Van Hiele level's of thinking 2 (formal deduction) if the student has passed the Van Hiele level's of thinking 0 (visualization) and 1 (analysis), and 5) students who produce hand or pen movements during group discussions on learning about quadrilaterals and triangles. Based on the selection process, the students who are the research subjects can be described in the table.1.

Table 1. Research Subjects

Subject	**Van Hiele level's of Thinking**			**Hand and Pen Gestures During Group Discussions**
	0	1	2	
ZA	Answer correctly = 5	Answer correctly = 5	Answer correctly = 4	Hand and Pen
AB	Answer correctly = 5	Answer correctly = 3	Answer correctly = 3	Hand

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The instruments used in the study were the main instrument and supporting instruments. The main instrument was the researcher herself because the researcher planned, implemented, collected data through recording, conducted VHGT, observation and interviews, analyzed data, drew conclusions and made a research report. Supporting instruments, namely recording devices, VHGT question sheets and interview guidelines. The data collection procedure was carried out as follows: 1) Recording students while completing VHGT using a handycam and an android cellphone, 2) Recording students during interviews using a handycam and an android cellphone. Observations were carried out to record the details of the answers and writing produced by students while completing the VHGT questions, and 3) Interviews were conducted after the subjects had finished working on the VHGT.

The collected data was analyzed using qualitative analysis techniques. Qualitative data analysis was conducted exploratively and continuously until complete or no new data was obtained on student gestures based on Van Hiele level's of thinking.

RESULTS AND DISCUSSION

Question VHGT given to 31 students of SMP Negeri 1 Ternate City. The VHGT test consists of 15 multiple choice questions, each consisting of 5 questions to measure each level of Van Hiele thinking: 0 (visualization), Van Hiele levels 1 (analysis), and Van Hiele levels 2 (informal deduction). Question VHGT Numbers 1-5 are questions about Van Hiele thinking levels 0, numbers 6-10 are questions about Van Hiele's thinking level 1, and numbers 11-15 are questions about Van Hiele level's of thinking 2. The evaluation criteria used are the Usiskin evaluation criteria (1982). Students are said to be at a certain Van Hiele level if the students can answer correctly at least 3 of the 5 questions given in each sub-test and the students are at the level n+1, if the student has passed the level. Students who answered 3 to 5 correctly for questions number 1-5 (Van Hiele levels 0) numbered 22 students, students who answered 3- 5 correctly for questions number 6-10 (Van Hiele levels 1) numbered 19, and students who answered 3-5 correctly for questions number 11-15 (Van Hiele levels 2) numbered 15 students. Part of the 15 students who were at the Van Hiele levels of thinking 2, were taken 2 students as research subjects who had fulfilled the research subject selection process, namely ZA and NB. These two students showed pointing gestures, representational gestures and writing at the Van Hiele levels of thinking as in table 2.

Table 2. Student gestures based on Van Hiele levels of thinking

Guest	Van Hiele Level's of Thinking		
	0	1	2
Pointing	ZA and NB	ZA and NB	ZA and NB
Representational	ZA and NB	ZA and NB	ZA and NB
Writing	ZA and NB	ZA and NB	ZA and NB

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Gestures Pointing to ZA and NB

ZA and NB used pointing gestures at Van Hiele thinking levels 0. ZA and NB pointed to pictures that were squares and triangles with their fingers and pens. The results of the researcher's (P) interview with ZA and NB are as described in Table 3.

Table 3. Results of interviews with ZA and NB

P	ZA	NB
From the following pictures K, L and M, which one is a rectangle?	Which is a quadrilateral with the shape K and M (pointing to K and M with your finger)	K and M are rectangular images (pointing to K and M with a pen)
Look at the following images of P, Q, and R. Which one is a triangle?	Here sir, the picture of P and R is a triangle (pointing to P and R with a pen)	Yani in Pak, P and R are triangles (pointing to P and R with finger)

ZA and NB use pointing gestures at Van Hiele thinking levels 1. ZA and NB point to 2 perpendicular diagonals of a rhombus.with finger and pen to state the correct relationship in each rhombus. The results of the researcher's (P) interview with ZA and NB are as described in table 4.

Table 4. Results of interviews with ZA and AB

P	ZA	NB
Look at the following 2 rhombus pictures, which connection is correct in each rhombus?	The correct answer is that the two diagonals are perpendicular to each other.	This is correct, sir, the two diagonals are perpendicular to each other
Show 2 diagonals perpendicular to each other in the 2 rhombus images?	These are the diagonals that are perpendicular to each other (pointing to 2 perpendicular diagonals with your finger)	These diagonals are perpendicular, sir (pointing to 2 perpendicular diagonals with a pen)

ZA and NB use pointing gestures at Van Hiele thinking levels 2. ZA and NB point to the diagonals of equal length in a rectangle and the diagonals of unequal length in a parallelogram with their fingers and pens to express the relationship between the properties of a rectangle and a parallelogram. The results of the researcher's (P) interview with ZA and NB are as described in table 5.

Table 5. Results of interviews with ZA and NB

P	ZA	NB
Which property does a rectangle have but is not a property of a parallelogram?	The diagonals are the same length	This is correct, sir, the diagonals are the same length.
Can you explain the diagonals of a rectangle and a parallelogram and show them?	I will draw a rectangleABCD and parallelogram ABCD too. The diagonals AC and BD in rectangle ABCD are equal in length (point to AC and BD in	Suppose there are 2 images, namely rectanglesABCD and parallelogram KLMN. Diagonals AC and BD (pointing at AC and BD on rectangle ABCD with a

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	rectangle ABCD with a pen), while the diagonals AC and BD in parallelogram ABCD are not equal in length (point to AC and BD in parallelogram ABCD with a pen)	pen), while diagonals KM and LN of parallelogram are not the same length (pointing at KM and LN on parallelogram KLMN with a finger)

Representational Gesture

ZA and NB used representational gestures at the Van Hiele levels of thinking 0. ZA and NB drew or described/visualized quadrilaterals and triangles with their fingers and pens. The results of the researcher's (P) interview with ZA and NB are as described in Table 6.

Table 6. Results of interviews with ZA and NB

P	ZA	NB
Look at the following images K, L and M, how do you know and how do you imagine that the shapes of images K and M are quadrilaterals and image L is not a quadrilateral?	Because K and M have 4 sides (describe/draw 4 sides in the air with your fingers) and L is not a quadrilateral because it only has 3 sides (describe/draw 3 sides in the air with your fingers)	Here's the thing, sir, I know from the picture that K and M have 4 sides (describe/draw 4 sides in the air with your finger) and L is not a quadrilateral because it only has 3 sides (describe/draw 3 sides in the air with a pen)
Look at the following images P, Q and R, how do you know and how do you imagine that the shape of images P and R is a triangle and image Q is not a triangle?	I know that P and R are triangles because they have 3 sides (draw 3 sides in the air with a pen) and Q is not a triangle because it has 4 sides (draw 4 sides in the air with a pen)	Because the figures P and R have 3 sides (drawing 3 sides in the air with your fingers) and Q has 4 sides, that's why Q is not a triangle (drawing 3 sides in the air with your fingers)

ZA and NB use representational gestures at Van Hiele levels of thinking 1. ZA and NB depict or describe/visualize which relationship is true in each right triangle ($\overline{GH}$ the longest side and is located in front of angle I) and which relationship is true in each rhombus (the two diagonals are perpendicular to each other). ZA and NB describe with finger and pen in the air. The results of the researcher's (P) interview with ZA and NB are as described in table 7.

Table 7. Results of interviews with ZA and NB

P	ZA	NB
Look at the following 2 rhombus pictures, how do you make and how do you imagine the 2 diagonals being perpendicular to each other?	This is how to make it, sir, from the opposite corner point, draw a straight line, it will form 2 diagonals that are perpendicular to each other (draw 2 perpendicular diagonals in the air with a pen)	The way to make it is like this, sir, I use the properties of rhombus, which are the two diagonals intersect and are perpendicular, from the corner point a straight line is drawn to form 2 diagonals that are perpendicular to each

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	other, sir (draw 2 perpendicular diagonals in the air with fingers)

ZA and NB use representational gestures at Van Hiele levels of thinking 2. ZA and NB depict or describe/visualize the relationship between the properties of a rectangle and a parallelogram with a finger and a pen in the air. The results of the researcher's (P) interview with ZA and NB are as described in table 8.

Table 8. Results of interviews with ZA and NB

Researchers	ZA	NB
Which property does a rectangle have that is not a parallelogram? Why did you choose to have the diagonals of a rectangle equal in length? How do you visualize these diagonals?	I will draw a rectangle ABCD and parallelogram ABCD too. The diagonals AC and BD in rectangle ABCD are the same length (point to AC and BD in rectangle ABCD with your finger), while the diagonals AC and BD in parallelogram ABCD are not the same length (point to AC and BD in parallelogram ABCD with a pen)	Suppose there are 2 images, namely rectangles ABCD and parallelogram KLMN. Diagonals AC and BD are the same length (pointing at AC and BD on rectangle ABCD with a pen), while diagonals KM and LN are not the same length (pointing at KM and LN on parallelogram KLMN with a finger)

Writing Gestures

ZA and NB used writing gestures at the Van Hiele levels of thinking 0. ZA and NB wrote squares and triangles on paper or worksheets with a pen. The results of the researcher's (P) interview with ZA and NB are as described in table 9.

Table 9. Results of interviews with ZA and NB

P	ZA	NB
Look at the following images K, L and M, try to describe again which image is a quadrilateral and which image is not a quadrilateral?	Here sir, the pictures K and M are quadrilaterals (write/draw K and M on paper with a pen) and the picture L is not a quadrilateral, the picture L is a triangle (write/draw L on paper with a pen)	If I look, the picture K and M are rectangles (writing/drawing K and M on paper with a pen) and I see the picture L is not a rectangle, but L is a triangle (writing/drawing L on paper with a pen)
Look at the following images P, Q and R, try to write again which image is a triangle and which image Q is not a triangle?	Here sir, the picture P and R are triangles (write/draw P and R on paper with a pen) and Q is not a triangle, the picture Q is a rhombus (write/draw Q on paper with a pen)	I will write again Sir, the picture P and R are triangles (write/draw P and R on paper with a pen) and the picture Q is not a triangle, but Q is a rhombus (write/draw Q on paper with a pen)

ZA and NB use writing gestures at Van Hiele levels of thinking 1. ZA and NB write 2 diagonals that are perpendicular to each other in a rhombus on paper with a pen to state the

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correct relationship in each rhombus. The results of the researcher's (P) interview with ZA and NB are as described in table 10.

Table 10. Results of interviews with ZA and NB

Researchers	ZA	NB
Look at the 2 rhombus pictures below, try drawing the 2 rhombuses again?	This is a picture of two sides of a rhombus (write/draw 2 sides of a rhombus with a pen)	I have already taken a picture, sir, this is a picture of the two sides of the rhombus (write/draw 2 sides of a rhombus with a pen)
Try writing/marking which are the 2 diagonals perpendicular to each other on each rhombus?	Yes, sir, I have drawn 2 diagonals that are perpendicular to each other in the first and second pictures (write/draw 2 perpendicular diagonals of a rhombus with a pen)	Here is the picture, sir. I have tried to draw 2 diagonals that are perpendicular to each other for the 2 rhombuses (write/draw 2 perpendicular diagonals of a rhombus with a pen)

ZA and NB used writing gestures at the Van Hiele levels of thinking 2. ZA and NB wrote the diagonals of equal length in a rectangle and the diagonals of unequal length in a parallelogram on paper with a pen to state the relationship between the properties of a rectangle and a parallelogram. The results of the researcher's (P) interview with ZA and NB are as described in table 11.

Table 11. Results of interviews with ZA and NB

Researchers	ZA	NB
Can you draw a rectangle and a parallelogram?	Here is the picture, sir, it's a rectangle. ABCD and parallelogram ABCD also (drawing rectangle ABCD and parallelogram ABCD with a pen)	I'll try to draw it, sir. I'll draw a rectangle. ABCD and parallelogram KLMN (drawing rectangle ABCD and parallelogram KLMN with a pen)
Can you mark/write down the diagonals of a rectangle and a parallelogram? Compare the diagonal sizes of a rectangle and a parallelogram.	Here, sir, the diagonals AC and BD in rectangle ABCD and parallelogram (draw AC and BD) rectangle ABCD and parallelogram with a pen). If the diagonals AC and BD in a rectangle are the same length, if the diagonals AC and BD in a parallelogram are not the same length (mark AC and BD) rectangle ABCD and parallelogramwith a pen)	Let me try to mark it, sir, these are the diagonals AC and BD in rectangle ABCD (drawing AC and BD with a pen). Next, I will mark/write the diagonals KM and LN (drawing KM and LN in parallelogram KLMN) with a pen). If the diagonals AC and BD in a rectangle are the same length, while the diagonals KM and LN in a parallelogram KLMN are not the same length (mark KM and LN with a pen)

ZA and NB used pointing gestures at Van Hiele levels of thinking 0. ZA and NB pointed to pictures of rectangles and triangles with their fingers and pens. They pointed to rectangles

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and triangles based on their appearance or visuals. Students used pointing gestures to focus attention on certain visual objects or geometric shapes (Masita et al., 2016; Mulbar et al., 2026).

ZA and NB use pointing gestures at Van Hiele levels of thinking 1. ZA and NB understand which relationship is true in each rhombus by pointing the two diagonals perpendicular to each other using finger and pen. Students use pointing gestures to understand the properties of rhombuses at Van Hiele's level of thinking 1 to focus attention on the relationship between the properties of rhombuses. Students using pointing gestures that function as a focus of attention on objects related to waking nature (Masita et al., 2016; Mulbar et al., 2026).

ZA and NB use pointing gestures at Van Hiele levels of thinking 2. ZA and NB understand the relationship between the properties of rectangles and parallelograms by pointing to the diagonals of equal length in rectangles and diagonals of unequal length in parallelograms with their fingers and pens to focus attention on the relationship between the properties of rectangles and parallelograms. Students use pointing gestures to focus attention on objects related to the properties of geometric shapes and connect them with the properties of other shapes (Masita et al., 2016; Mulbar et al., 2026).

ZA and NB used representational gestures at Van Hiele levels of thinking 0. ZA and NB drew or described/visualized quadrilaterals and triangles with their fingers and pens in the air. Students use representational gestures to depict geometric shapes (Mulbar et al., 2026). Students use representational gestures to depict geometric shapes concretely with their fingers and pens in the air (Sagita & Hendriana, 2021).

ZA and NB use representational gestures at Van Hiele levels of thinking 1. ZA and NB depict or describe/visualize which relationship is correct in each rhombus, namelyThe two diagonals are perpendicular to each other using a finger and a pen in the air. Students use representational gestures to describe or simulate the properties or rules that are fulfilled in geometric shapes (Masita et al., 2016; Mulbar et al., 2026).

ZA and NB use representational gestures at Van Hiele levels of thinking 2. ZA and NB depict or describe/visualize to understand the properties of rectangles and parallelograms by drawing diagonals of equal length in a rectangle and diagonals of unequal length in a parallelogram using fingers and pen in the air.Representational gestures function as visual perception of the given geometric problems (Masita et al., 2016; Mulbar et al., 2026). Students use representational gestures to describe or simulate properties or rules that are fulfilled in geometric shapes (Mulbar et al., 2026).Representational gestures help draw and visualize concrete or abstract objects or events (Prayitno & Surianastutiningtyas, 2023; Sagita & Hendriana, 2021).

ZA and NB used writing gestures at Van Hiele levels of thinking 0. ZA and NB wrote rectangles and triangles on paper with pens. Students used writing gestures at Van Hiele's level of thinking 0, based on the visual characteristics or appearance of the shapes of rectangles

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and triangles. Students used writing gestures based on the appearance of geometric images (Masita et al., 2016; Sagita & Hendriana, 2021).

ZA and NB use writing gestures at Van Hiele levels of thinking 1. ZA and NB write 2 diagonals that are perpendicular to each other in a rhombus on paper with a pen to express the correct relationship in each rhombus. Students use writing gestures at Van Hiele's level of thinking 1 to analyze the parts of a rhombus and observe the properties of the elements in the rhombus. Without realizing it, students often use writing gestures when writing relationships in geometric shapes (Masita et al., 2016).

ZA and NB used writing gestures at Van Hiele levels of thinking 2. ZA and NB wrote the equal diagonals of a rectangle and the unequal diagonals of a parallelogram on paper with a pen to express the relationship between the properties of rectangles and parallelograms. Students used writing gestures to understand the relationship between rectangles and parallelograms. The writings rectangle and parallelogram left an imprint on the paper. Students used writing gestures when emphasizing the understanding of the relationship between one shape and another (Sagita & Hendriana, 2021; Sulistyorini, 2019).Writing gestures are used to provide explanations by leaving permanent marks or marks on the answer sheet (Prayitno & Surianastutiningtyas, 2023; Ruhama, 2024; Sagita & Hendriana, 2021).

CONCLUSION

Students use pointing, representational, and writing gestures at Van Hiele levels of thinking 0, 1, and 2. Students use pointing gestures at Van Hiele levels of thinking 0 to focus attention on a particular visual object or geometric shape. Students use pointing gestures at Van Hiele levels of thinking 1, functions as a focus of attention on objects related to the nature of waking. Students use pointing gestures at Van Hiele levels of thinking 2 functions as a focus of attention on objects related to the properties of geometric shapes and connecting them with the properties of other geometric shapes. Students use pointing gestures with their fingers and pens.

Students use representational gestures at Van Hiele levels of thinking 0 to depict or visualize geometric shapes concretely with their fingers and pens in the air. Students use representational gestures at Van Hiele levels of thinking 1, to describe or simulate the properties or rules that are fulfilled in geometric shapes. Students use representational gestures at the Van Hiele levels of thinking 2 to describe or simulate the properties or rules that are fulfilled in geometric shapes. Students use representational with fingers and pen.

Students use writing gestures at Van Hiele levels of thinking 0 based on the visual characteristics or appearance of geometric shapes. Students use writing gestures at Van Hiele levels of thinking 1, when writing relationships within a geometric figure. Students use writing gestures at Van Hiele levels of thinking 2 to understand the relationship between one

geometric figure and another. The geometric figure's writing leaves a permanent imprint on the paper. Students use writing gestures with a pen.

This study is limited to junior high school students' gestures based on Van Hiele levels of mathematical thinking. There is scope for further research on elementary and high school students' gestures, or equivalent, at Van Hiele levels of mathematical thinking or other levels of mathematical thinking.

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