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Research articles

Analysis of students' anxiety based on van Hiele's levels in solving geometry problems

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Abstrak Kecemasan matematika timbul salah satunya karena rasa tidak nyaman ketika berhadapan dengan masalah matematika termasuk dalam menyelesaikan masalah geometri. Penelitian kualitatif ini bertujuan untuk menganalisis kecemasan siswa dalam menyelesaikan soal geometri ditinjau dari level van Hiele. Enam puluh siswa SMP kelas 7 dilibatkan dalam penelitian. Data penelitian dikumpulkan melalui tes, angket, observasi, dan wawancara semi terstruktur. Analisis data dilakukan melalui tiga tahap yaitu kondensasi data, penyajian data, serta penarikan dan verifikasi kesimpulan. Hasil penelitian menunjukkan bahwa siswa yang berada di level visualisasi memiliki tingkat kecemasan sedang dan panik, siswa pada level analisis memiliki kecemasan sedang, dan siswa pada level deduksi informal memiliki kecemasan rendah. Tingginya tingkat berpikir geometris siswa belum tentu mengakibatkan kecemasan yang rendah atau sebaliknya. Kecemasan matematika dapat mendukung siswa, akan tetapi pada tingkat kecemasan tertentu, dapat merugikan siswa.

Kata kunci *Geometri, Kecemasan matematika, Level van Hiele*

Abstract Mathematics anxiety emerges due to discomfort when dealing with mathematical problems, including problems in geometry. This qualitative research aims to analyze how students' anxiety in solving the problems referring to van Hiele's levels. The participants were sixty grade 7 students. Data was collected through a test, questionnaire, observations, and semi-structured interviews. It was then analyzed following the stages of condensation, presentation, and drawing and verifying conclusions. The research found that students at the *visualization level* have moderate anxiety and panic levels, students at the *analysis level* have moderate anxiety, and students with informal deduction levels have low anxiety. The high level of students' geometric thinking does not necessarily result in lower anxiety or vice versa. Math anxiety is able to encourage students, but at a certain level, it could be detrimental to students.

Keywords *Geometry, Mathematical anxiety, van Hiele's levels*

Introduction

Most students think mathematics is difficult (Hwa, 2018; Segumpan & Tan, 2018). They feel nervous, anxious, and afraid whenever they learn mathematics (Szczygiel & Pieronkiewicz, 2022). This could affect their affective states in developing their mathematical knowledge. Santoso (2021) explains that mathematics anxiety is a psychological aspect that needs to be a concern for mathematics teachers because it has an influence on mathematical performance

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(Braham & Libertus, 2018; Orbach et al., 2020; Xie et al., 2019; Zhang et al., 2019); one of the mathematical performances is in geometry.

Geometry is considered a scourge for students, that might cause anxiety when dealing with it (Anita, 2014; Mamiala et al., 2021). Some studies show that students found difficulties in some geometric topics caused by math anxiety (Gutierrez-Rubio et al., 2020; Sunardi et al., 2019; Auliya, 2016; Sorvo et al., 2017; Novack & Tassell Janet, 2017). Also, students' geometry difficulties are usually related to solving geometry problems (Sunardi et al., 2019; Alghadari et al., 2020) and proving geometry theorems (Ni'mah et al., 2020). Some research (Sunardi et al., 2019; Dewi et al., 2020) connect mathematics anxiety with geometry problems based on van Hiele's levels of geometric thinking. For example, Sunardi et al. (2019) researched students' anxiety in solving geometry problems through van Hiele's levels: visualization, analysis, and informal deduction. Considering the importance of the theory to understand students' geometric thinking and anxiety that hinder students' problem-solving in geometry topics, specifically, a further study that extend our understanding of the topic is critical, including the current study.

This study aims to analyze students' mathematics anxiety in solving geometry problems in each level of van Hiele's theory. This is because mathematical anxiety can influence students' abilities in learning. Therefore, mathematics anxiety is a psychological aspect that needs to be paid attention to by mathematics educator. This study is expected to identify students' anxiety in solving geometry problems in each level of students' geometric thinking, which could be used to design learning instructions. This research-informed design is likely to mitigate students' anxiety in geometry, which in turn contribute to the quality of mathematics teaching and learning.

Theoretical Review

The level of geometric thinking by van Hiele

Geometric thinking is explained by the existence of a particular popular theory, called van Hiele's theory. It is a theory developed by Pierre Marie Hiele and Dina van Hiele-Geldof in 1950 that has been internationally recognized (Teppo, 1991; Alex & Mammen, 2016). There are five levels of geometric thinking according to the theory, namely level 0 (visualization), level 1 (analysis), level 2 (informal deduction), level 3 (deduction), and level 4 (rigor) (Bashiru & Nyarko, 2019). It is characterized by two main features: a definition of levels of students' cognitive understanding of geometry and descriptions of processes through which students progress through the levels (Abdullah & Zakaria, 2013; Hansen, Drews, & Dudgeon, 2014; Kospentaris et al., 2016). The theory originally consists of five sequential and hierarchical discrete levels of geometric thinking (Armah & Kissi, 2019) as shown in Table 1.

According to van de Walle (1994), characteristics of the van Hiele level are: (1) the levels are gradual, in which to arrive at any level above level 0, students must take the previous level, (2) the level does not depend on age such as Piaget's stages of development, (3) geometry experience is the most significant factor influencing development at each of these levels, and (4) when instruction or language is used at a higher level than what students have there will be less communication. From these levels, students cannot move up to a higher level without passing a lower one because, according to van Hiele, the ordering of geometric topics must be adjusted to the difficulty level (Unaenah et al., 2020; Armah & Kissi, 2019). Armah and Kissi (2019) give an example of van Hiele's theory in geometry. At level 1, learners recognize figures by appearance alone, compare the figures with their prototypes or everyday things, and categorize

them. At level 2, learners start analyzing and naming properties of geometric figures, but they do not understand the interrelationship between different types of figures. Then in secondary levels, learners move to level 3, where they see the interrelationship between different types of figures. They can create meaningful definitions and give informal arguments to justify their reasoning at this level. Learners at level 4 can give deductive geometric proofs. They understand the role of definitions, theorems, axioms and proofs. The last, learners at level 5 understand the formal aspects of deduction, such as establishing and comparing mathematical systems. The learners learn that geometry needs to see the "construction" of geometric systems. The basis of the theory is the idea that a student's growth in geometry takes place in terms of distinguishable levels of thinking.

Table 1. The level of geometric thinking in van Hiele's theory

Level	Characteristics
Level 0 (visualization)	Students recognize geometric shapes from their visual characteristics and appearance but have not been able to understand and determine the geometric properties and characteristics of the shapes shown
Level 1 (analysis)	Students can determine the properties of a shape by observing, measuring, experimenting, drawing, and making models but cannot see the relationship between several geometric shapes
Level 2 (informal deduction)	Students are able to find out the related relationships between a geometric shape and other geometric shapes. Students who are at this stage already understand the sequencing of geometric shapes
Level 3 (deduction)	Students can compile evidence, not just accept evidence and have understood the importance of the role of elements that are not defined and those that are prescribed. However, students do not understand the usefulness of a deductive system
Level 4 (rigor)	Students have started to realize how important the accuracy of the basic principles that underlies a proof

Mathematics anxiety

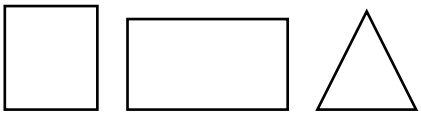
Anxiety is an emotional reaction that depends on feelings of self-including tension, stress, and self-distrust (Tovote et al., 2015). Students' anxiety in the teaching and learning could occur because of early education. Also, it might happen when students do not understand school topics well. For example, if a student wants to organize the information provided, then the information seems to swirl in his brain and is not processed or stored in his long-term memory (Foose, 2014; Rix, 2015; Sunardi et al., 2019). Mathematics anxiety refers to feelings of tension, fear, and physiological reaction (i.e., negative affect) and self-deprecatory thoughts and worries about one's performance (i.e., negative cognition) that interfere with solving mathematics problems in ordinary life and academic situations (Rozgonjuk et al., 2020). Furthermore, mathematics anxiety has been described as experiencing feelings of panic and helplessness when asked to solve a mathematical task or problem (Tobias & Weissbrod, 1980). Psychological as well as physiological symptoms may appear when feeling anxious about mathematics (Chang & Beilock, 2016). Thus, mathematics anxiety is feelings of tension, fear, and physiological reaction (i.e., negative affect) and self-deprecatory thoughts and worries about one's performance (i.e., negative cognition) when asked to solve a mathematical task or problem.

This research refers to three aspects of anxiety according to Whyte and Anthony (2012): (1) physiologic aspects, such as heart palpitations and feeling like fainting, pressure on the chest, pacing, loss of appetite, nausea, unable to hold back, urinating, experiencing cold sweats, and flushed face; (2) cognitive aspect indicated by disturbed attention, poor concentration, forgetfulness, thinking barriers, confusion, and fear; and (3) affective aspects shown by easily distracted, impatient, restless, tense, nervous, worried, guilty, and embarrassed.

Methods

The current research applied a qualitative approach involving 60 seventh-grade students. Data was collected using van Hiele geometry test, anxiety questionnaire, observation, and interview. The test was developed on the topic of Pythagorean theorem consisting of 10 problems and every 2 problems are based on each indicators of van Hiele level (Table 1). The sample problems are shown in Table 2. The van Hiele Geometry Test has been declared valid by experts' assessment, the test instrument has a reliability index of 0.663 (reliable).

Table 2. Sample problems from van Hiele's geometry test

Level	Sample question
Level 0 (visualization)	1. Look at pictures below!  (a) (b) (c) Decide which one is a triangle, square, and rectangle!
Level 1 (analysis)	3. State the properties of the various triangles based on the size of the angles!
Level 2 (informal deduction)	6. Pak Adi has two plots of land in a triangle shape. Land A has side lengths of 12 m, 16 m, and 20 m. Land B has side lengths of 8 m, 15 m, and 12 m. Determine the type of triangle from the shape of the plot of land!
Level 3 (deduction)	8. Investigate the longest side if $(m^2 - n^2), 2mn,$ and $(m^2 + n^2)$ is right triangles!
Level 4 (rigor)	9. A child is 36 m from the bottom of a building. He saw the top of the building with an elevation angle of 30°. Above the building is a helicopter with an elevation angle of 45° which will land on top of the building. Calculate the height of the helicopter from the top of the building!

In observation, we observed students' anxiety during the test using the developed rubric (Figure 1). This observational data was analyzed to obtain information related to students' anxiety when working on the given geometry test.

No.	Student	Physiological Aspects			Cognitive Aspect		Affective Aspect					Notes
		Sweating	Tense Face	Flushed Face	Confused	Afraid	Shut Up	Moving Legs	Moving Fingers	Nervous	Playing A Writing Instrument	
1.												
2.												

Figure 1. The format of the observation rubric

After all students finished working on the test, they were given a mathematics anxiety questionnaire comprising 25 items. The sample items are presented in Table 3. It has been declared valid by the experts' assessment and it has a reliability index of 0.821 (reliable).

Table 3. The sample items of the mathematics anxiety questionnaire

Aspect	Sample items
Physiological	I felt my heart beating fast when the teacher suddenly gave me a math test.
	I was moving back and forth when the teacher handed out math test questions.
Cognitive	I could concentrate while taking a math test in class.
	I became forgetful when I am faced with difficult math problems.
Affective	I stayed calm when I could not solve math problems.
	I stayed relaxed while taking an impromptu math test.

The results of the students' test and questionnaire were categorized based on the van Hiele levels and mathematics anxiety (Table 4). Afterward, students who represented each category based on van Hiele levels and mathematical anxiety level were purposively selected to be interviewed in a semi-structured way. The interviews were conducted individually via Google Meet and in person, which lasted about 1 hour. The interview aimed to confirm students' answers and ask some points based on the questionnaire. We clarified ambiguous answers. If necessary, students in the interview could write down their answers again. Sample questions on the interview based on the uestionnaire are: what did you do when the teacher give math tests, did your heart flutter when you did the test? If so, why could this happen? (Is it because the time you use was spent without producing answers and students have less and less time to work on), and did you often feel so weak that you want to pass out when solving problems? If so, why did you experience that? (Do you have a congenital disease, or you can't control your body when you're worried, so you feel weak).

Three stages of qualitative data analysis, according to Miles, Huberman, and Saldana (2014) that, were used in this research. In the first stage, data condensation, students' answers based on the test and questionnaire were coded referring to the indicators of van Hiele and mathematics anxiety levels. According to Usiskin (1982), the ability to classify students' thinking levels is considered to be at the van Hiele *n* level if students correctly answers questions at level n and at any lower level. In other words, if a student is able to complete three of the five questions included at the van Hiele level, then the student is included in the level two category. The Likert scale guided the data analysis for the questionnaire with five answer options—calculation of the level of math anxiety categories ranging from low to panic (Table 4).

Table 4. The category of students' mathematics anxiety

Score range	Types
$25 \leq x < 50$	Low
$50 \leq x < 75$	Moderate
$75 \leq x < 100$	High
$100 \leq x < 125$	Panic

Then, the selected students were interviewed, and the transcripts were coded to identify their anxiety and the sources of the anxiety. In the data display, we described students based on the student's test answers, anxiety questionnaires, observation, and interview results. In drawing and verifying conclusions, we noticed patterns in the students' responses and made comparisons

from that with the interviews and relevant studies. After obtaining a conclusion, verification was carried out by employing a source triangulation. It is a technique for checking the credibility of data by examining data obtained through several sources. The data obtained was rechecked at the same start at different times or checked using other sources.

Findings and Discussion

Overall, Table 5 presents the test and questionnaire result. There were five students fulfilling the van Hiele's level. Other students were in pre-visualization level where they could not solve the level 0's problems or just solve one from two problems. Thus, the five students were interviewed.

Table 5. The map of students' van Hiele levels and mathematics anxiety

van Hiele's level	Level of students' anxiety	Number of students
Level 0 (Visualization)	Moderate	2
Level 2 (Informal deduction)	High	1
	Moderate	1
	Low	1

Table 5 shows that most students had moderate anxiety. Some students were at level 0 (visualization), level 1 (analysis), and level 2 (informal deduction). This finding is in line with prior research (Bashiru & Nyarko, 2019; Lestariyani et al., 2014; Nasifah et al., 2022) where the level of students' geometric thinking in junior high school was from the visualization to the l informal deduction.

Level 0 (Visualization)

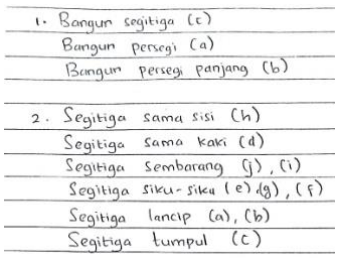
The student at visualization level, who was analyzed had a moderate anxiety level and encoded as SL0s (ASP). In Figure 2, the student could determine the shape's name and correctly classified them. In number 3, the student was incorrect in explaining a triangle's feature based on its angle's magnitude. The student had an incomplete answer on number 4. However, the student did not finish numbers 8, 9, and 10. Although the student could determine the longest side on number 8, it could not be accomplished during the interview. Referring to the answer, the student reached the level of visualization because number 1 and 2 were answered correctly.

Observations during the test show that the student looked confused (cognitive aspects) and it was noted that the student looked right and left (Whyte & Anthony, 2012). From the questionnaire answers, the student experienced anxiety in physiological aspects (faster palpitations), as well as cognitive aspects (forgetfulness, disturbed attention, fear, thinking barriers), and affective aspects (guilt, tension, shame, anxiety) (Whyte & Anthony, 2012). Furthermore, an interview was conducted related to the questionnaire and the student's answer. Below is a snippet of the interview with SL0s.

Researcher : *Why do you feel not right when you have your own answer?*
SL0s (ASP) : *I do not know, but just disappointed*
Researcher : *Why do you become forgetful when you are faced with such a difficult question?*
SL0s (ASP) : *I cannot remember anything, so I cannot answer the questions.*

Based on the interview, the student had difficulty doing it, so the student could only do numbers 1, 2, 5, and 7. Thus, the student experienced a moderate anxiety level with physiological symptoms (rapid palpitations) and tended to experience anxiety in cognitive and affective aspects.

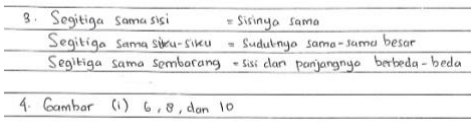
Level 0



1. Triangle (c)
   Square (a)
   Rectangle (b)

2. Equilateral triangle (h)
   Isosceles triangle (d)
   Arbitrary triangle (j), (i)
   Right triangle (e), (g), (f)
   Pointed triangle (a), (b)
   Blunt triangle (c)

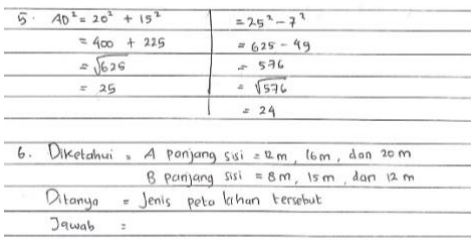
Level 1



3. Equilateral triangle = sides are equal
   The triangle is equillised right = the angle isequally large
   Arbitrary triangle = different sides and lengths

4. Picture (i) 6, 8, and 10

Level 2



5. $AD^2 = 20^2 + 15^2$ $= 25^2 - 7^2$
   $= 400 + 225$ $= 625 - 49$
   $= 625$ $= 576$
   $= \sqrt{625}$ $= \sqrt{576}$
   $= 25$ $= 24$

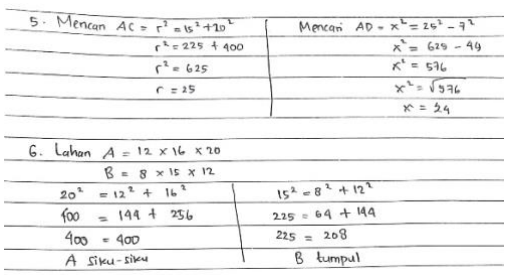
6. Given:
   A side length = 12m, 16m, and 20m
   B side length = 8m, 15m, and 12m
   Asked: type of land map
   Answer:

Figure 2. SL0s's answer on the test

Level 2 (Informal deduction)

In this level, there were three students. They had low, moderate, and high anxiety, respectively. First, we described a student with informal deduction level and high level of anxiety, who was initialized as SL2t (AMR). The student's answer is shown in Figure 3.

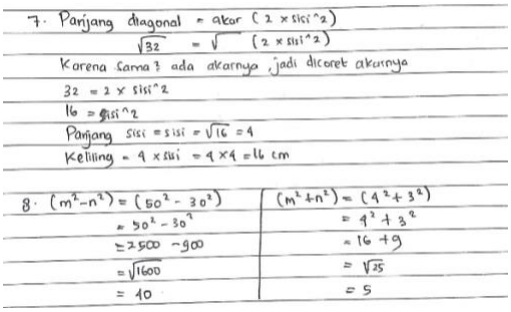
Level 2



5. Finding AC = $r^2 = 15^2 + 20^2$
   $r^2 = 225 + 400$
   $r^2 = 625$
   $r = 25$
   Finding AD = $x^2 = 25^2 - 7^2$
   $x^2 = 225 + 400$
   $x^2 = 576$
   $x = 24$

6. Land A=$12 \times 16 \times 20$
   B = $8 \times 15 \times 12$
   $20^2 = 12^2 + 16^2$ $15^2 = 8^2 + 12^2$
   $400 = 144 + 256$ $225 = 64 + 144$
   $400 = 400$ $225 = 208$
   A = right triangle B= blunt triangle

Level 3



7. Diagonal length = $\sqrt{2 \times s^2}$

$\sqrt{32} = \sqrt{2 \times s^2}$

$32 = 2 \times side^2$

$16 = \text{side}^2$

Circumference $= 4 \times 4 = 16cm$

Figure 3. SL2t's answers on the test

The student's answers to numbers 5, 6, and 7 were correct, but the student did not complete numbers 8, 9, and 10 because they were not understood well (the student's confession during the interview). Based on the answers, the student reached the level of informal deduction. The student admitted in the interview that he could only do numbers 1 to 2, and had difficulty answering the remaining questions as indicated in the following interview.

Researcher : *What about number 3? Can you explain?*
SL2t (AMR) : *I do not know.*
Researcher : *You have already answered this.*
SL2t (AMR) : *(Silence, looks confused). Actually, I do not understand from number 3 to number 10. I was told by a friend.*

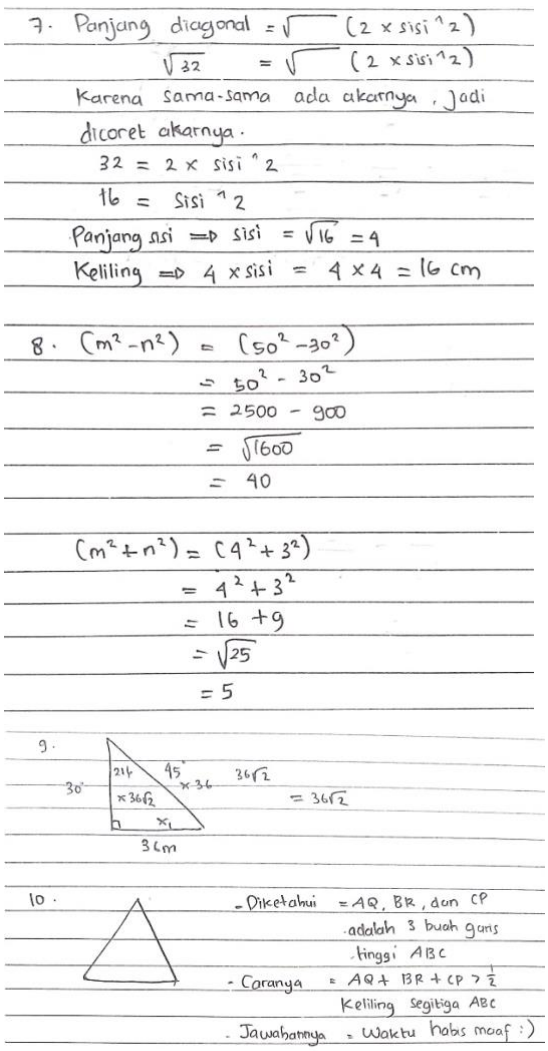
When the student was difficult to solve the remaining problem, this made him feel anxious, then he received answers from his friends. In the observation, the student was quiet and restless when solving the problems (affective aspect). Another symptom of anxiety cold also be seen from his answers to the questionnaire. He had anxiety in physiological aspects (heart beating fast, pressure on the chest, cold sweat, pacing, frequent urination when taking math tests), cognitive aspects (forgetfulness, poor concentration, impaired attention, confusion, fear, thinking barriers), and affective aspects (guilt, tension, shame, worry, nervousness, restlessness, easily distracted, impatient to end the test immediately). Almost all indicators of anxiety in these three aspects were felt by the student. This was also evidenced in the interview. The student was already sweating and blushed. He also admitted that he did not like math. The student reported that he used to be panic when dealing with math problems and often went to the toilet. The following interview also support SL2t's anxiety.

Researcher : *Why are you afraid of math?*
SL2t (AMR) : *I am afraid about formulas. There are so many formulas that made me confused.*
Researcher : *Did you feel your heart was beating fast during yesterday's test?*
SL2t (AMR) : *Yes. I keep on learning but I still forget.*
Researcher : *Why do you think?*
SL2t (AMR) : *Because I am afraid I cannot do it, I am worried about being wrong. I am worried that I got a bad score.*
Researcher : *Why did you look tense when you did a math test?*
SL2t (AMR) : *Yes, because I am afraid I cannot do it*

The interview reveals that the student was afraid of mathematics. It was possibly due to the panic when answering the questionnaire, there was an incorrectly ticked statement. The calculation of the questionnaire changed the student from high anxiety to the panic level. The student experienced anxiety from three aspects: physiological, cognitive, and affective. The student, thus, was included in the visualization level with panic level of anxiety. In addition, it was found that the student had many ways to complete the test, but it resulted in increased anxiety.

Another student in this category of geometric thinking had a moderate anxiety level, coded as SL2s (RAF). The student's result of the test is presented in Figure 4. The student was already running out of time when it reached number 10. From the results of such work (Figure 4), the student reached the level of informal deduction. However, when the interview was conducted, the student admitted that he could only understand the questions and did it until number 4 because he had difficulty with the remaining numbers. This made the student feel a little anxious; therefore, cheating on a friend's answers. This was evidenced during the interview with the student.

Level 3



Translation:

7. Diagonal length = $\sqrt{2 \times s^2}$

$\sqrt{32} = \sqrt{2 \times s^2}$

Because each has root then

$32 = 2 \times side^2$

$16 = \text{side}^2$

The length of the side = $\sqrt{16} = 4$

Circumference = $4 \times 4 = 16cm$

8. $(m^2 - n^2) = (50^2 - 30^2)$

$= 50^2 - 30^2$

$= 2500 - 900$

$= \sqrt{1600}$

$= 40$

$(m^2 + n^2) = (4^2 + 3^2)$

$= 4^2 + 3^2$

$= 16 + 9$

$= \sqrt{25}$

$= 5$

Level 4

10. Given: AQ, BR, and CP is 3 pieces of ABC high line

How: AQ+BR+CP > $\frac{1}{2}$ circumference of the triangle ABC

Answer: Time is up, sorry.

Figure 4. SL2s's answers on the test

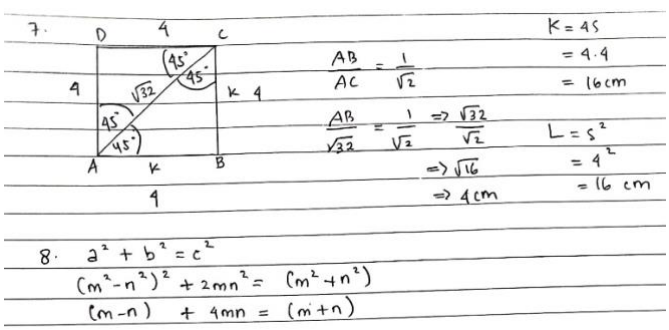
Researcher	:	*I want to ask number 8. Are you just trying to use numbers, right? What do you think about the follow-up?*
SL2s (RAF)	:	*I just filled it using other numbers.*
Researcher	:	*So, which is the hypotenuse? Then it's a right triangle, isn't it?*
SL2s (RAF)	:	*That is m^2+n^2. It looks like a right triangle. I'm confused*
Researcher	:	*Is number 9 the same as number 10?*
SL2s (RAF)	:	*It is also hard. For number 9, if it's not wrong, I am using a comparison, but I forgot I do not know. In number 10, I only wrote what is known.*
Researcher	:	*Why did you feel not confident when you have your own answers?*
SL2s (RAF)	:	*Because my friend saw it, so I feel guilty if my answer is wrong. The answer is actually wrong, even though I see a friend*

In the interview, the student seemed hesitant and difficult. The result of the observation record shows that the student tend to be focus when solving the problem, but we saw the student open a notebook to work on number 5 and the next numbers. Form the questionnaire, the student experienced anxiety in physiological aspects (loss of appetite and feeling weak), cognitive aspects (poor concentration and confusion), and affective aspects (guilt, tension, and impatience). However, during the interview, the student admitted that he was not so anxious when doing math problems. Thus, the geometric thinking of the student who was originally at the informal deduction level turned out to be at the level of analysis, with anxiety being at a moderate level.

The last student in this category has a low level of anxiety, (SL2r ANA). The student could solve questions number 1 to number 7. The answer to number 7 to 10 can be seen in Figure 5. Since the student could solve questions until number 7, he reached the level of informal deduction. The student admitted that it was difficult to work on numbers 8 to number 10 as shown in the following interview.

Researcher	:	*Okay, go on number 8. This is not finished yet. Try to finish it first!*
SL2r (ANA)	:	*It is difficult because it was like never being taught. I am confused. But I tried it first (silently working)*
Researcher	:	*(10 minutes later) Are you sure, aren't you? Is this evidently a right triangle?*
SL2r (ANA)	:	*It is not like that. I still don't understand how to look for it*
Researcher	:	*Okay, are you doubt it? How about numbers 9 and 10?*
SL2r (ANA)	:	*Alright, numbers 9 and 10 are also very difficult, I have no idea. But number 9 seems to use comparisons, but I do not understand the angles and the picture.*

Level 3



Level 4

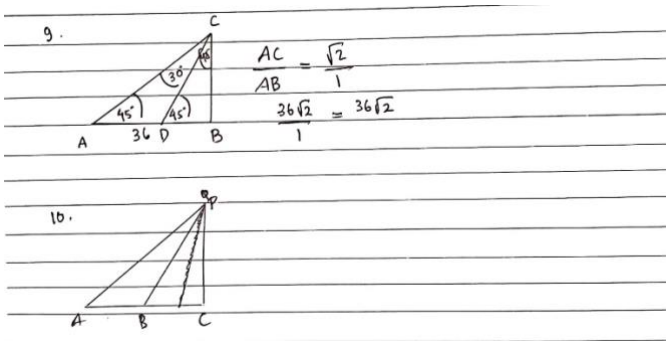


Figure 5. SL2s's answers on the test

In the observation, the student seemed to be focused in solving the problems. The questionnaire informed that the student experienced anxiety in the affective aspect alone, namely anxiety when not finding the answer during the test. During the interview, the student admitted that he was not so anxious when doing math problems. Thus, the student only experienced affective anxiety on one indicator.

In summary, Table 6 presents a description of students' mathematical anxiety in each van Hiele's level of geometric thinkin. The results of this study show that there were students at level 0 (visualization), level 1 (analysis), and level 2 (informal deductio). This is similar to prior research (Bashiru & Nyarko, 2019; Lestariyani et al., 2014; Nasifah et al., 2022) about the level achieved by junior high school students in geometric thinking. In addition to the level, the mathematics anxiety felt by students varied. There were students who experienced low anxiety, moderate anxiety, high anxiety, or panic anxiety. There was one student at the analysis level who had moderate anxiety and one student with a level of informal deduction has low anxiety. This is relevant to what Wahid et al. (2014) and Anita (2014) found that about the student's level of anxiety.

Table 6. Description of students' mathematical anxiety in each van Hiele's level

van Hiele's level	Anxiety level	Description
Level 0 (Visualisation)	Panic	• Students experience fast heart palpitations, then pressure on the chest, to the point where they experience cold sweat when doing math tests. Students also walk back and forth and often urinate or leave the classroom briefly on every math test (physiological aspect) • Students experience confusion, fear, and difficulty to the point that they forget the formula, which results in disturbed concentration (cognitive aspect). • Students experience nervousness, cannot wait to end the test, tense, embarrassed, worried if they cannot complete the test, easily distracted, and feel guilty if they answer carelessly (affective aspect)
	Moderate	• Students only experience a faster beating heart due to an impromptu math test (physiological aspect) • Students experience fear and barriers to thinking and become forgetful ,such as forgetting formulas so that attention is easily distracted so they become unfocused (cognitive aspect)

van Hiele's level	Anxiety level	Description
Level 1 (Analysis)	Moderate	• Students experience anxiety, tension, embarrassment, and guilt when giving answers at random (affective aspect). • Students experience a loss of appetite when they cannot do a math test until they get a low score (physiological aspect). • Students experience confusion and poor concentration (cognitive aspect). • Students experience tension during tests, guilt for answering carelessly, and cannot wait to end the math test (affective aspect).
Level 2 (Informal Deduction)	Low	• Students only experience anxiety when they cannot answer math test (affective aspect).

Several studies (Rohmah, 2019; Yudianto et al., 2021) indicate that students' level of geometric thinking based on van Hiele's theory do not linearly correlate to students' mathematical anxiety. In other words, the higher the geometric level, the lower the anxiety students have or vice versa. It is also evidenced in this study where students with informal deduction have high anxiety. In fact, Ramadan (2019) reveals that when students' anxiety increase, they will try harder, but their lack of understanding make the condition worse, which will increase their anxiety. If this continues to happen until a "vicious circle" is formed, it will be a stimulus to their anxiety. Mathematics anxiety that occurs could have a positive or negative impact on each individual. While low levels of anxiety have been shown to be motivating for students, high anxiety levels are reported to be exclusively detrimental (Mohammed et al., 2021). Mathematics anxiety could encourage motivate students. Students who prepare themselves against injury, pain, punishment, separation, and frustration are the examples about the motivating characteristics when the anxiety is stimulating and taking precautions, and if it is negative, it is easier to overcome the fear of being protective and unsuccessful (Akbayir, 2019).

Conclusion

This study found that students with different van Hiele's level of geometric thinking have varied level of mathematical anxiety. Students in the visualization level experienced a moderate and panic level of anxiety indicated by symptoms on physiological, cognitive, and affective aspects. Students who are at analysis level experienced moderate level of anxiety with symptoms in physiological, cognitive, and affective aspects as well. At the level of informal deduction, students experienced low levels of anxiety with symptoms in affective aspects. Therefore, this study suggests that students' mathematics anxiety does not linearly relate to their level of geometric thinking based on van Hiele's theory. A further study, including quantitative one, is required to examine the relationship.

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