



Journal of Educational Sciences

Journal homepage: <https://jes.ejournal.unri.ac.id/index.php/JES>



P-ISSN
2581-1657

E-ISSN
2581-2203

Profile of Critical Thinking of Grade XI Students at SMAN 1 Torue in Solving Circle Problems Based on Van Hiele's Levels of Thinking

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ARTICLE INFO

Article history:

Received: 13 Jan 2026

Revised: 24 Jan 2026

Accepted: 26 Jan 2026

Published online: 05 Feb 2026

Keywords:

Circle,
Critical thinking, Geometry,
High School Student,
Problem solving,
Van Hiele theory

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Article Doi:

<https://doi.org/10.31258/jes.10.2.p.2301-2315>

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ABSTRACT

Critical thinking is an essential competence in mathematics learning, particularly in circle topics that demand conceptual understanding and geometric reasoning. One relevant framework for examining this ability is Van Hiele's levels of geometric thinking. This study aims to describe students' critical thinking skills in solving circle problems based on their Van Hiele levels. A qualitative descriptive approach was employed. The subjects consisted of three Grade XI students, each representing Van Hiele level 0 (visualization), level 1 (analysis), and level 2 (informal deduction). Data were collected through circle problem-solving tests and interviews. Critical thinking was analyzed using Ennis's indicators: elementary clarification, advanced clarification, strategies and tactics, and inference. The findings show that students at the visualization level understood problems and applied basic procedures but did not demonstrate sufficient inference and evaluation skills. Students at the analysis level explained relationships among circle elements and applied strategies appropriately, though their ability to recheck results was limited. Meanwhile, students at the informal deduction level exhibited more comprehensive critical thinking across all indicators. The study concludes that the higher the Van Hiele level, the stronger the quality of students' critical thinking in solving circle problems.

1. Introduction

In the 21st century, education faces new challenges due to rapid technological development and globalization. Education is a key determinant of national progress and plays a crucial role in producing human resources with intellectual, mental, and emotional quality (Lestari, 2023). Mastery of subject matter alone is no longer sufficient; students are now required to develop higher-order thinking skills, particularly critical thinking. Such skills are essential for adapting, reasoning logically, and competing in an increasingly complex global environment (Jamil &

Murniati, 2025). As noted by Arifah et al (2023), education should not merely transmit knowledge but also foster deep and critical thinking. Mathematics holds a strategic position in the national curriculum as a continuous subject from the elementary level. Mathematics learning is not only about mastering concepts but also about shaping logical, systematic, critical, and creative thinking (Rahmah et al., 2022). As a discipline, mathematics supports students' reasoning through structured patterns and rules (Zebua et al., 2024).

Through mathematics, students are expected to think critically and rationally to solve real-life problems (Miftahunida et al., 2024). Rosiana et al (2023) emphasize that critical thinking is closely tied to problem-solving, involving processes of collecting, interpreting, analyzing, and evaluating information to reach valid conclusions. Teachers must understand students' critical thinking abilities to design appropriate learning objectives and monitor their development (Fauzi et al., 2021). Danora et al (2020) further highlight that practicing critical thinking equips students to build logical solutions, solve problems, and explain everyday phenomena. According to Ennis, critical thinking is logical and reflective thinking directed toward decision-making about what to believe or do. Ennis identifies several indicators of critical thinking, including elementary clarification, advanced clarification, strategies and tactics, and inference (Zakiah et al., 2019; Apiati & Hermanto, 2020; Danora et al., 2020).

The PISA 2022 results show that although Indonesia's ranking improved compared to 2018, scores in all three literacy domains declined, indicating that the ranking increase does not fully reflect learning achievement (Kemdikbudristek, 2023). Consistently, PISA reveals that Indonesian students' performance in scientific literacy and analytical problem solving remains low, reflecting weak critical thinking skills needed to analyze information, evaluate truth, and apply knowledge meaningfully (OECD, 2024; Azmi dkk., 2025; Azmi et al., 2025). Hasan et al (2022) found that students with strong literacy skills tend to collect and analyze information accurately before determining problem-solving strategies, while those with weaker literacy struggle to understand problems, leading to poor critical thinking in finding solutions. These findings suggest that critical thinking emerges from reasoning and problem-solving processes involving deep analysis of information and situations.

Geometry provides a context for developing mathematical reasoning through conjecture-making, validation, and classification of geometric objects, thereby enhancing both geometric understanding and critical thinking (Sulistiowati, 2022). Jannah & Budiman (2022) note that circle topics demand precision and have strong potential to foster students' critical thinking. However, many students still face difficulties in solving circle problems due to limited critical thinking. The circle is an important topic in mathematics because it relates to everyday problems, such as calculating fence costs for semicircular parking areas (Harti & Imami, 2022; Putri et al., 2022). Mastery of circle material requires not only recognition of circle elements and calculation of circumference and area but also understanding of underlying conceptual relationships. Muharrom & Kadarisma (2022) report that many students struggle with circle problems due to low conceptual understanding,

reliance on memorizing formulas, and lack of prerequisite knowledge, making circle problem solving a relevant context for examining critical thinking.

Interviews with mathematics teachers at SMA Negeri 1 Torue revealed that circle learning in Grade XI has been conducted using a contextual approach, starting from concrete examples. Students showed varied levels of understanding and reasoning in analyzing circle elements and applying them to problem solving. This indicates differences in students' critical thinking abilities in geometry, particularly in circle topics. Variations in how students acquire and process information in geometry lead to differences in geometric thinking, which in turn affect their critical thinking in analyzing and solving problems (Rahmawati et al., 2022). Van Hiele's theory is used to examine students' critical thinking in geometry through its levels of thinking. Arnita et al (2024) found that only a small number of students reached the informal deduction level (level 2) or formal deduction level (level 3), with none achieving the rigor level (level 4). These findings show that Van Hiele's theory effectively identifies stages of geometric thinking and maps specific difficulties at each level.

Students' critical thinking, viewed through Van Hiele's levels of geometric thinking, is an important area of study. Previous research has examined geometric thinking based on Van Hiele's theory across various topics, but studies specifically addressing students' critical thinking profiles in solving circle problems remain limited. Therefore, this study aims to describe the critical thinking profiles of Grade XI students at SMA Negeri 1 Torue in solving circle problems based on Van Hiele's levels of geometric thinking. This research is expected to provide a comprehensive picture of students' critical thinking characteristics at each level of geometric thinking.

2. Methodology

This study employed a descriptive qualitative design. Qualitative research yields descriptive data in the form of written and spoken words from observed participants. A descriptive qualitative approach was chosen because this study aimed to explore, examine, and provide an in-depth description of high school students' critical-thinking profiles in solving circle problems, viewed through the Van Hiele levels of geometric thinking. In qualitative research, the researcher serves as the primary instrument, directly involved in data collection, analysis, and interpretation in a natural setting without manipulating variables (Sidiq & Choiri, 2019). The study was conducted at SMA Negeri 1 Torue during the odd (first) semester of the 2025/2026 academic year. Participants were students of Grade 11 (XI MIPA 6) selected by purposive sampling. Selection was based on the results of a Van Hiele geometric-thinking level classification test, considering representation across Van Hiele levels and the recommendation of the mathematics teacher. Three students were chosen as primary cases for in-depth analysis, each representing a different Van Hiele level of geometric thinking.

The research instruments comprised the researcher as the main instrument and several supporting instruments. The researcher acted as observer, interviewer, data

collector, data analyst, and conclusion-maker. Supporting instruments included: (1) a Van Hiele level classification test based on the Van Hiele Geometry Test (VHGT), consisting of 25 items to identify students' geometric-thinking levels from Visualization (Level 0) to Rigor (Level 4); (2) a written test containing two circle problems developed according to Ennis's indicators of critical thinking to identify students' critical-thinking profiles at each Van Hiele level; and (3) an interview guide used to probe students' rationales, strategies, and thinking processes when solving circle problems. Interviews were conducted flexibly during and after the written tests to strengthen data interpretation.

Instrument validity was secured through expert judgment by a mathematics education lecturer specializing in geometry, who evaluated content validity, item construction, and alignment with critical-thinking indicators and Van Hiele levels. Given the qualitative nature of the study, data validity was addressed through credibility and dependability rather than statistical tests. Credibility was enhanced by technique triangulation—comparing written-test results and interview data—and by member checking with participants. Dependability was maintained through auditing of the research process by supervisors from data collection to conclusion drawing. Data analysis followed Miles and Huberman's model, consisting of data condensation, data display, and conclusion drawing and verification. Data condensation involved selecting and simplifying test and interview data, which were then presented as narrative descriptions and tables. Conclusions were drawn iteratively based on patterns and consistencies supported by the data. The indicators used in this study were adapted from Ennis (1985) and adjusted to the problem-solving stages developed by Polya, as described in Table 1.

Tabel 1. Critical Thinking Indicators Based on Polya's Steps

Polya's Step	Ennis' Critical Thinking Skills	Indicator
Understanding the Problem	<i>Elementary clarification</i>	At this stage, students' critical thinking skills enable them to identify known and unknown information in a problem, rephrase the problem in their own words, and determine the relevant mathematical concepts.
Devising plan	<i>Advance clarification</i>	At this stage, students' critical thinking skills enable them to determine the appropriate solution strategy for a problem and explain the reasons for choosing that strategy based on the mathematical concepts used.
Carrying out the plan	<i>Strategies and tactics</i>	At this stage, students' critical thinking skills enable them to carry out the steps of the solution systematically according to the plan that has been prepared and to use mathematical procedures appropriately.
Looking back	<i>Inference</i>	At this stage, students' critical thinking skills enable them to draw conclusions, recheck the correctness of their answers, and assess the suitability of the solution to the problem given.

3. Results and Discussion

Based on the results of the Van Hiele geometry test in class XI MIPA-6, students demonstrated varying levels of geometric thinking. A total of 10 students had not yet reached the level of geometric thinking, 10 students were at level 0 (visualization), 4 students at level 1 (analysis), and 4 students at level 2 (informal deduction). For a more in-depth analysis, one representative subject was selected from each of levels 0, 1, and 2 based on the highest correct answer achievement, recommendations from the mathematics teacher, and the students' willingness to participate. Subsequently, data were obtained through written tests and interviews to illustrate students' critical thinking abilities at each Van Hiele level, based on Ennis's critical thinking indicators, particularly within Polya's problem-solving stages. The results of this analysis are discussed to provide an overview of how levels of geometric thinking influence the quality of students' critical thinking in solving circle problems.

1) Critical Thinking Skills of Students at Level 0 (Visualization)-(WA)

Subject WA is at Van Hiele level 0 Visualization, characterized by the ability to recognize elements of a circle based on visual appearance without a deep understanding of their conceptual relationships. In understanding the problem, WA was able to identify the problem context and accurately determine the given information and what was being asked. This indicates that the critical thinking indicator for Elementary Clarification is fulfilled. However, WA did not optimally demonstrate critical thinking on the Advance Clarification indicator due to an inability to explain the relationships among the measure of the central angle, arc length, and radius when planning/selecting a problem-solving strategy. This can be seen in the interview transcript data in Table 2.

Table 2 Interview Transcript of Subject WA Related to Critical Thinking in Understanding the Problem

Dialogue	
PN03	: What information did you get to solve Alicia's problem?
WA04	: The information I got is that the diameter is 28 m, the circle's radius is half the diameter, which is 14 m, and the smaller radius is 7 m, with the angle as shown in the figure.
PN05	: Okay, is that all?
WA06	: There's more. The question asks for the perimeters of regions ABCD and EFGH.
PN07	: Okay. Try to explain in your own words what the problem asks!
WA08	: It asks for the perimeters of ABCD and EFGH. So, if you want to build a fence you need to know the perimeter first.
PN09	: Which areas are to have their perimeters found and be fenced?
WA10	: (points to the figure) This region ABCD and this one EFGH
PN11	: Okay. You already know the information and what is being asked. What is your strategy to help Alicia solve the problem?
WA12	: I will solve the problem using the arc-length formula. The formula is $(\text{angle} / 360^\circ) \times 2\pi r$, or a fraction of the circle's circumference.
PN13	: Why did you choose to use the arc-length formula?
WA14	: (points to arc AD in the figure) This curved part hasn't had its length determined. In a circle, this is called an arc.

- PN15 : So, because of that you use the arc-length formula?
 WA16 : Yes, because that is what will be fenced.
 PN17 : Now after that, what is your next step?
 WA18 : Just plug in the known information.

In the stage of carrying out the plan, subject WA applied the arc length formula to determine the perimeter of the fenced region. WA was able to calculate each component of the perimeter in a systematic sequence by combining the known information until arriving at the final result. Thus, the Strategies and Tactics indicator is fulfilled, as shown in WA's written test answer sheet in Figure 1 below.

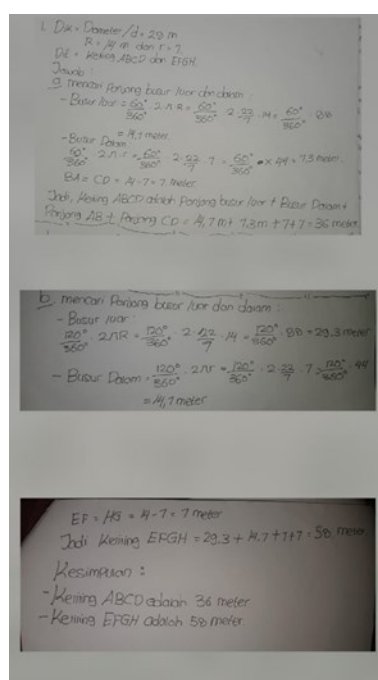


Figure 1. Written Test Answer Sheet of Subject WA

At the interview stage, subject WA did not yet demonstrate critical thinking ability on the Inference indicator, as WA only referred to the results of calculations using formulas without providing the underlying logical explanation when justifying conclusions and rechecking the correctness of the answers. In addition, WA was unable to propose possible alternative solutions. These statements are presented in Table 3 below."

Table 3. Interview with Subject WA — Critical Thinking in the "Looking Back"

Dialogue	
PN33	: Why do you think the yellow flower is larger than the red flower?
WA34	: Because its angle is larger.
PN35	: Okay. Besides the angle, is there anything else that affects it?
WA36	: The arc.
PN37	: Okay, the arc. Can you explain the relationship between arc length, the size of the angle, and the length of this straight segment?
WA38	: It's hard to explain.
PN39	: Okay. So, how can you be sure that your answer is correct?

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- WA40 : I'm not really sure it's correct, but if the formula I used is correct, then the result I get will also be correct.
- PN41 : Good. Good. Lastly, can you make a conclusion from your answer?
- WA42 : Yes. My conclusion is that the perimeter of ABCD is 36 meters and the perimeter of EFGH is 58 meters. So, Alicia needs 36 meters of fence for the red flower garden and 58 meters for the yellow flower garden.
- PN43 : Why are you able to conclude that?
- WA44 : Because that is the result I obtained from the formula. It also solves Alicia's problem. In addition, this can be applied in everyday life. For instance, suppose we have a circular garden, but we want to arrange different sections for the flowers. Then we create boundaries with fences and calculate them using this method.
- PN45 : Alright. Is there another faster or simpler way to get the same result?
- WA46 : I don't know.
-

Based on subject WA's responses and interview results, this study shows that at Van Hiele level 0 (Visualization), students' critical thinking skills are relatively developed in problem understanding and carrying out the plan, but have not yet developed optimally in the indicators of further explanation, inference, and evaluation. These findings indicate that students at level 0 (Visualization) tend to rely on shape recognition and the direct application of formulas. This result is consistent with the study by Aini et al (2020), which found that students at the visualization stage are able to identify problems by mentioning relevant information but struggle to provide conceptual explanations. Similar findings were reported by Palayukan et al (2023), showing that students at Van Hiele level 0 tend to solve problems visually and procedurally without being supported by deep conceptual reasoning, as reflected in the high percentage of correct answers on visualization-level tasks.

2) Critical Thinking Skills of Students at Level 1 (Analysis)-SM"

At Van Hiele level 1 (Analysis), subject SM was able to identify the elements of a circle and explain the relationship between angle measure, arc length, and radius in determining the perimeter of the garden area. This ability shows that SM not only recognizes shapes visually but also begins to analyze the circle conceptually while formulating a plan to solve the problem. These findings indicate that SM at the analysis level supports the development of critical thinking skills in the aspects of Elementary Clarification and Advance Clarification, as SM was able to explain the known information and the rationale for choosing the problem-solving strategy, as shown in Table 4 below.

Table 4 Interview with Subject SM regarding Critical Thinking in Understanding the Problem.

Dialogue	
PN01	: In this question, there is Alicia. Can you explain what Alicia's problem is?
SM02	: Alicia has a flower garden and wants to build a fence around it. So, she needs to find the perimeter to build the fence, which will be red and yellow flowers.
PN03	: What information do you have to solve Alicia's problem?
SM04	: The information I got here is from the picture, which shows two circles. These circles are sketches of Alicia's garden. Alicia's garden is circular with a diameter of 28 meters, and the angle size of the garden sections with flowers is also shown. Alicia's problem is

- to build fences around the flower sections. The problem states that Alicia plans to fence the parts of the garden with flowers, with the boundaries along ABCD and EFGH.
- PN05 : Okay. Then, please explain in your own words how you would help Alicia solve her problem.
- SM06 : First, I wrote down the known information: the diameter is 28 meters. I want to use the radius, so I divided the diameter by two, which is 14 meters. Then, since there is another smaller circle inside, the radius of the smaller circle is 7 meters. For the red flower garden, the angle of ABCD is 60 degrees, and for the yellow flower garden, the angle of EFGH is 120 degrees. So, I started by finding how many meters long arc AD is.
- PN07 : What formula did you use to find the length of arc AD?
- SM08 : I used the arc length formula.
- PN09 : Why did you choose the arc length formula?
- SM10 : Because in the picture, the lengths of arcs AD and BC are not shown. So, I used the arc length formula to find out how long the arcs are. Since the radius is already known, it is easy to use in the arc length formula.

Subject SM was able to consistently carry out the problem-solving plan by combining the arc length and radius according to each garden area, in line with the strategy during the interview. This demonstrates the fulfillment of the Strategies and Tactics indicator, as SM was able to appropriately select and apply the problem-solving procedures, as shown in Figure 2.

$d = 28 \text{ m}$ $r = \frac{d}{2} = 14 \text{ m}$ $r = 7 \text{ m}$
 $\angle ABCD = 60^\circ$ $\angle EFGH = 120^\circ$
 Dik: Panjang keliling pagar bunga merah dan bunga kuning
 Dit: a. Panjang keliling pagar bunga merah
 • Busur AD = $\frac{60^\circ}{360^\circ} \cdot 2 \cdot 14 \cdot \pi$
 $= \frac{60^\circ}{360^\circ} \cdot 2 \cdot 14 \cdot 3,14$
 $= \frac{60^\circ}{360^\circ} \cdot 87,92$
 $= 14,65 \text{ m}$
 Busur BC = $14,65 \text{ m}$
 • Busur BC = $\frac{60^\circ}{360^\circ} \cdot 2 \cdot 14 \cdot \pi$
 $= \frac{60^\circ}{360^\circ} \cdot 2 \cdot 14 \cdot 3,14$
 $= \frac{60^\circ}{360^\circ} \cdot 87,92$
 $= 14,65 \text{ m}$
 Busur EC = $14,65 \text{ m}$
 Panjang keliling pagar bunga merah (saat AB + sa. CD)
 $K = \text{Busur AD} + \text{sa. AB} + \text{Busur BC} + \text{sa. CD}$
 $= 14,65 + 7 + 14,65 + 7$
 $= 35,95 \text{ m}$
 Jadi, panjang keliling pagar bunga merah adalah 35,95 m.

b. Panjang keliling pagar bunga kuning
 • Busur FG = $\frac{120^\circ}{360^\circ} \cdot 2 \cdot 14 \cdot \pi$
 $= \frac{120^\circ}{360^\circ} \cdot 2 \cdot 14 \cdot 3,14$
 $= \frac{120^\circ}{360^\circ} \cdot 87,92$
 $= 29,30 \text{ m}$
 Busur FH = $29,30 \text{ m}$
 • Busur EH = $\frac{120^\circ}{360^\circ} \cdot 2 \cdot 14 \cdot \pi$
 $= \frac{120^\circ}{360^\circ} \cdot 2 \cdot 14 \cdot 3,14$
 $= \frac{120^\circ}{360^\circ} \cdot 87,92$
 $= 29,30 \text{ m}$
 Busur BG = $29,30 \text{ m}$
 Panjang keliling pagar bunga kuning (saat EF + sa. GH)
 $K = \text{Busur FG} + \text{sa. EF} + \text{Busur EH} + \text{sa. GH}$
 $= 29,30 + 7 + 29,30 + 7$
 $= 72,90 \text{ m}$
 Jadi, panjang keliling pagar bunga kuning adalah 72,90 m.

Figure 2. Written Test Answer Sheet of Subject SM.

SM's inference ability has not yet developed optimally. Although the student was able to conclude that a garden with a larger angle has a longer fence, this conclusion was not accompanied by verification of the calculations or evaluation of the correctness of the result. This can be seen in the transcript data presented in Table 5 below.

Table 5. SM Subject Interviews related to Critical Thinking in the “Looking Back”

Dialogue	
PN19	Why do you think yellow flowers are bigger than red flowers?
SM20	: Because the angle is larger, it also affects the length of the arc, hence the yellow quantity.
PN21	: Can you explain what is the relationship between the length of the arc, the size of the angle, the length of the sides?
SM22	: If the arc length and the bow are large, they are interconnected. The larger the angle, the longer the bow will be. If it's side long, just follow the fingers.
PN23	: How do you ensure that your calculation is correct?
SM24	: I do not know. I am not confident in this answer because the result is a decimal number.
PN25	: Last, could you summarize Alicia's problem in your own words?
SM26	: The perimeter of the yellow flower garden is longer because its angle is 120° , while the red flower garden is only 60° . The calculation is performed by adding the arc length and the straight sides of each region.
PN27	: Why can you conclude like that?
SM28	: Because that is the result I obtained from the calculation, and it enables me to assist Alicia in determining the length of the fence required for both the red and yellow flower gardens.
PN29	: Are there any other faster or simpler ways to get the same results?
SM30	: Maybe there's an easy way, but I don't know.

Based on the results of the written test and interview, these findings indicate that the characteristics of students at Van Hiele level 1 (Analysis) allow for the development of critical thinking skills in the aspects of elementary clarification, advance clarification, and strategies and tactics, but do not yet optimally support the aspect of inference. This result is consistent with the study by Kurnia & Hidayati (2022), which stated that students at the analysis level are able to identify and analyze parts and attributes of circles informally, but are not yet fully capable of conducting evaluative reasoning and drawing deep conclusions. Thus, although students are able to present conclusions and relate them to angle measures and arc lengths, the conclusions remain oriented toward the final result alone, as they follow formulas without verification of calculations or evaluation of correctness. The consistency of these findings is also demonstrated in the study by Rahmawati et al (2022), which showed that students at Van Hiele level 1 (Analysis) tend to understand the properties and basic relationships among geometric elements, but still experience difficulties in making inferences and rechecking the accuracy of their solutions.

3) Critical Thinking Skills of Students at Level 2 (Informal Deduction)-EY

Subject EY reached Van Hiele level 2 (Informal Deduction), as reflected in the ability to conceptually connect the elements of a circle in solving problems. EY was able to clearly understand the problem context and focus on the objective of determining the length of the fence in two garden areas. EY not only mentioned the known information but also explained the rationale for selecting concepts and problem-solving strategies. EY planned the solution by linking the relationships among angle measures, garden perimeter, arc length, and radius according to the information provided in the problem. This demonstrates that subject EY meets the

indicator of elementary clarification according to Ennis, as EY was able to accurately identify the core problem and relevant information, and also fulfills the indicator of advance clarification, as EY provided logical justification for the concepts and strategies used, rather than merely applying formulas procedurally. This is evident in the interview transcript presented in Table 6.

Table 6. EY Interview on Critical Thinking in Understanding Problems

Dialogue	
PN01	: Can you explain, what is Alicia's problem?
EY02	: Yes, before looking at the problem, here Alicia has a flower garden. Alicia's problem is that she wants to fence her garden, so I need to calculate the length of the fence surrounding area ABCD, which is the red flower garden, to solve the first problem. The second problem is calculating the length of the fence surrounding area EFGH, which is the yellow flower garden
PN03	: What information did you get to solve this Alicia problem?
EY04	: The figure is already provided here. So, this is the illustration of Alicia's garden. She plans to make flower gardens in red and yellow sections. The garden is circular with a diameter of 28 meters. Since the diameter is 28, the radius is half of that, which is 14 meters. This shaded red area, ABCD, is the red flower garden. And this yellow area, EFGH, is the yellow flower garden.
PN05	: Okay. You already know the information and what is being asked in the problem. Then, please explain in your own words how you would help Alicia solve her problem.
EY06	: I start by noting that the angle for the red flower section is 60 degrees and the angle for the yellow flower section is 120 degrees. (pointing to the figure in the problem) For the red flower area ABCD, first I calculate the arc lengths AD and BC, as well as the side lengths AB and CD.
PN07	: What formula do you use to find the arc length of AD and BC?
EY08	: The arc length formula, namely the known angle divided by the full angle of the circle, then multiplied by the circumference of the circle.
PN09	: Why did you choose to use the arc formula?
EY10	: To determine the arc lengths AD and BC. If it were the entire circle, then it would be the circumference of the circle.

At the stage of implementing the plan, EY demonstrated strong strategies and tactics by performing calculations systematically and combining arc lengths with straight sides/radii according to the characteristics of each garden area. EY consistently adjusted the central angles and radii in each calculation and selected the value of π that facilitated the computation process. These calculations are presented in Figure 3 below.

a.) # Mencari Panjang busur AD

$$P_{\text{busur}} = \frac{60^\circ}{360} \times 2\pi r$$

$$= \frac{60^\circ}{360} \times 2 \times \frac{22}{7} \times 14$$

$$= \frac{60^\circ}{360} \times 88$$

$$= \frac{5.280}{360} = 14,6667 \text{ m} \Rightarrow \text{dibulatkan } 14,67$$

mencari panjang busur BC

$$P_{\text{busur}} = \frac{60^\circ}{360} \times 2\pi r$$

$$= \frac{60^\circ}{360} \times 2 \times \frac{22}{7} \times 7$$

$$= \frac{60^\circ}{360} \times 44$$

$$= \frac{2.640}{360} = 7,333 \text{ m} \Rightarrow \text{dibulatkan } 7,34 \text{ m}$$

menghitung Panjang sisi AB = sisi CD

$$(R-r) \times (14-7)$$

$$= 7$$

Jadi Panjang Busur AD + Panjang sisi AB + Panjang busur BC + Panjang sisi CD

$$= 14,68 + 7 + 7,34 + 7$$

$$= 36,02 \text{ m}$$

Jadi Panjang pagar yang mengelilingi daerah bunga berwarna merah adalah 36,02 m

b.) # Mencari Panjang busur FE

$$P_{\text{busur}} = \frac{120^\circ}{360} \times 2\pi r$$

$$= \frac{120^\circ}{360} \times 2 \times \frac{22}{7} \times 14$$

$$= \frac{120^\circ}{360} \times 88$$

$$= \frac{10.560}{360} = 29,333 \text{ m} \Rightarrow \text{dibulatkan } 29,34$$

Mencari Panjang busur EH

$$P_{\text{busur}} = \frac{120^\circ}{360} \times 2\pi r$$

$$= \frac{120^\circ}{360} \times 2 \times \frac{22}{7} \times 7$$

$$= \frac{120^\circ}{360} \times 44$$

$$= \frac{5.280}{360} = 14,6667 \text{ m} \Rightarrow \text{dibulatkan } 14,68 \text{ m}$$

menghitung Panjang sisi EF = sisi GH

$$(R-r) \times (14-7)$$

$$= 7$$

Jadi Panjang busur FE + Panjang sisi EF + Panjang busur EH + Panjang sisi GH

$$= 29,34 + 7 + 14,68 + 7$$

$$= 58,02 \text{ m}$$

Jadi Panjang pagar yang mengelilingi daerah bunga berwarna kuning adalah 58,02 m

Figure 3. Written Test Answer of Subject EY.

In addition, EY's inference ability appeared to be more developed compared to students at the previous level. At the re-examination stage, EY demonstrated inference skills by linking differences in garden area size with variations in central angles and arc lengths, as well as by explaining the relationship among central angle, radius, diameter, and arc length in determining the perimeter. EY's confidence in the results, accompanied by logical conceptual reasoning, is reflected in the interview transcript data presented in Table 7.

Table 7. EY Interview on Critical Thinking in the "Looking Back"

Dialogue	
PN23	: Why do you think the yellow flower area is bigger than the red flower area?
EY24	: Because judging from the large angle, it is bigger in the yellow area. Only in its surroundings is that the length of the bow is really large. If the length of the sides is the same. The only difference is the angle and the length of the arc.
PN25	: Can you explain what is the relationship between the length of the arc, the size of the angles, and the length of the sides?
EY26	: They are in contact to find the length of the fence. Because the circle is an angle, the diameter is also used with the fingers. So if you are looking for this circumference formula, you are asked. So you need corners, you need fingers. It means they are related. The length of the arc adjusts the size of the angle, and the length of the sides follows the diameter and radius, all of which are in a circle.
PN27	: Okay. So, how can you be sure that your answer is correct?
EY28	: The formula may be wrong, but the calculation I did was correct.
PN29	: Finally, can you draw conclusions from ?
EY30	: Yes. The conclusion of the matter is Alicia. From the garden which is in the shape of a circle. The garden circle is divided to plant a little red flowers. Planted with a slight yellow color. Only then will the rest be emptied, maybe to install benches. You can use the arc length formula and remember the diameter and radius of the circle to help keep the calculation accurate. It has to do with it because he is in a circle. Only the sides of his fingers are the same, his fingers are connected.

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- PN31 : Why can you conclude like that?
 EY32 : I concluded from the calculations I did, and it could be that this happened in real life, the calculation can be done as long as you understand the nature of the circle.
 PN33 : Good. Are there any other faster or simpler ways to get the same results?
 EY34 : Nope. because the use of the arc length formula is essential in the calculation.
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Based on the results of the written test and interview, the findings indicate that subject EY at Van Hiele level 2 (Informal Deduction) possesses more advanced critical thinking skills encompassing all four aspects: elementary clarification, advance clarification, strategies and tactics, and inference. This result is consistent with the study by Riera et al (2022), which stated that students at the informal deduction level are able to integrate visual, logical, and applied skills in problem solving, although they are not yet fully consistent in evaluating the results obtained. Furthermore, Giovanni et al (2022) also emphasized that students at this level are capable of utilizing, planning, and solving problems systematically as well as drawing logical conclusions, although reflection and verification of alternative solutions remain limited.

4. Conclusion

Based on the results and discussion, it can be concluded that students' critical-thinking abilities in solving circle problems, viewed from the Van Hiele levels of geometric thinking, show significant differences across levels. Students at Level 0 (Visualization) can recognize the shape and elements of the circle and perform problem solving procedurally, but they are not yet able to relate concepts in depth or draw conclusions supported by logical justification. Students at Level 1 (Analysis) demonstrate improved ability to link problem information with relevant mathematical concepts and to plan and execute solution strategies in a systematic sequence; however, their evaluation processes and conclusion drawing are still not optimal. Meanwhile, students at Level 2 (Informal Deduction) exhibit more comprehensive critical-thinking skills, characterized by coherent conceptual linking, systematic selection and application of strategies, and drawing conclusions supported by conceptual explanations. Thus, this study shows that the higher the students' Van Hiele level, the better the fulfillment of Ennis's critical-thinking indicators—elementary clarification, advanced clarification, strategies and tactics, and inference—in solving circle problems.

Acknowledgement

The author would like to thank Tadulako University, particularly the Faculty of Teacher Training and Education and the Mathematics Education Study Program, for the academic support and research facilities provided. Gratitude is also extended to the supervising lecturers and instrument validators for their guidance and valuable feedback. In addition, the author appreciates the participation of all parties involved in this study, whose contributions enabled the successful completion of this article.

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How to cite this article:

Pratama, C. P., Sukayasa., Hadjar, I., & Nurhayadi. (2026). Profile of Critical Thinking of Grade XI Students at SMAN 1 Torue in Solving Circle Problems Based on Van Hiele's Levels of Thinking. *Journal of Educational Sciences*, 10(2), 2310-2315.
