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Original Article

Why geometry feels difficult: A phenomenological inquiry into junior high school students' learning experiences in Indonesia

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Abstract
Geometry is an essential component of mathematics that supports students in developing logical, critical, and spatial thinking skills, yet many students continue to find this material difficult to master. This study explored, in depth, eighth-grade students' experiences of learning geometry through a hermeneutic phenomenological approach. Data were collected using an open-ended questionnaire completed by ten eighth-grade students (5 males and 5 females, aged 13-15) from a private junior high school in Mataram City, West Nusa Tenggara, Indonesia, and were analyzed following Braun and Clarke's thematic analysis, assisted by an artificial intelligence tool (ChatGPT) during initial coding and subsequently verified manually by the researchers. The analysis produced six initial codes, condensed into five categories and, ultimately, three overarching themes: (1) pedagogical barriers and limited use of learning aids, (2) the complexity of geometry concepts, and (3) the lack of contextual application and student confidence. These findings indicate that geometry learning difficulties are not caused solely by students' cognitive limitations but are closely related to instructional strategies, the nature of the material itself, and students' psychological readiness. By foregrounding students' own voices, this study offers a more holistic account of geometry learning difficulties than achievement-score data alone can provide. It recommends implementing more contextual, adaptive, and supportive learning strategies, using visual media aligned with students' Van Hiele levels of thinking, to strengthen their spatial reasoning skills and confidence.
Keywords: contextual learning, geometry, learning difficulties, phenomenology, Van Hiele theory

1. Introduction

Geometry is one of the important branches of mathematics that plays a significant role in developing students' logical, critical, and spatial thinking abilities. This material is not only conceptually important but also frequently encountered in everyday life (Hendriyanto et al., 2021). Through geometry learning, students are expected to understand flat and spatial shapes as a foundation for solving both mathematical problems and real-world tasks that require visualization, measurement, and reasoning about space.

Despite this importance, many students consider geometry to be difficult and confusing material because it demands abstract thinking ability and the imagination of shapes that cannot always be directly observed (Lestari & Naila, 2021; Silmi Juman et al., 2022). This difficulty is consistent with a broader body of evidence on spatial reasoning: geometric problem-solving depends heavily on students' capacity to mentally visualize, rotate, and manipulate shapes, and students who have not yet developed this capacity tend to struggle regardless of how well they know relevant formulas (Buckley et al., 2019; Pittalis & Christou, 2010). Research by Ananda Dwi Putri and Hanifah Fitriyani (2024) showed that students in elementary schools already experience difficulties in understanding geometry concepts, particularly in visualization and spatial reasoning, while Marlinda Indah Eka Budiarti (2020) found that students' geometry problem-solving abilities vary significantly based on Van Hiele thinking levels and gender differences. These difficulties often persist into secondary education, where students encounter more complex geometric concepts such as transformation, congruence, and spatial figures.

Given the importance of geometry as a foundation for understanding more complex mathematical material, instruction needs to be delivered in an accessible and engaging manner. In practice, however, classrooms still face obstacles such as monotonous teaching methods, limited use of visual media, and students' lack of confidence when facing geometry problems (Nurjanah & Juliana, 2020). An overly strong emphasis on memorizing formulas without reinforcing underlying concepts encourages mechanical rather than meaningful learning, and low use of interactive media, such as Articulate Storyline-based materials, makes geometry lessons feel less engaging (Nurhidayah et al., 2025). Visual, exploratory, and contextual approaches play an important role in building deep understanding of geometric ideas (Nuriah et al., 2025), a pattern also reflected in studies showing that dynamic visualization tools such as GeoGebra can meaningfully improve students' conceptual and representational understanding of geometry (Azizah et al., 2021; Bhagat & Chang, 2015).

Previous studies have identified various factors contributing to geometry learning difficulties. Hasan (2020) found that students experienced scaffolding difficulties when solving spatial geometry problems, while Dian Angriani and Tampa (2022) revealed challenges in geometric literacy problem-solving. Sulistiowati et al. (2019) emphasized that students' difficulties were closely tied to their Van Hiele thinking levels, and a systematic review by Naufal et al. (2021) similarly concluded that the effectiveness of geometry instruction depends strongly on aligning teaching with students' current Van Hiele level and metacognitive awareness. Amalia (2023) specifically examined transformation-geometry difficulties among seventh-grade students, while more broadly, students' difficulties in mathematical problem-solving have been linked not only to conceptual gaps but also to affective factors such as confidence and self-efficacy (Pajares & Miller, 1994; Tambychik & Meerah, 2010).

Most of the studies cited above, however, rely primarily on tests, achievement scores, or closed instruments to measure the extent of students' geometry difficulties, with comparatively few studies exploring, in depth, how students themselves experience and interpret these difficulties as they occur in the classroom. This leaves a gap in the literature: little is known about the first-person, lived meaning that struggling students attach to their own geometry learning process, particularly in the Indonesian junior secondary context, where phenomenological studies of geometry learning remain scarce and where the use of AI-assisted qualitative coding as a transparent, auditable analytic aid has rarely been documented.

To help close this gap, the present study adopts a hermeneutic phenomenological approach combined with thematic analysis to directly explore students' experiences in the classroom, focusing not only on cognitive difficulties but also on the affective and psychological aspects that are often overlooked. Van Hiele's theory of geometric thinking stages serves as an important reference, since many junior high school students are still in the early stages of visualization and analysis (Ayu Putri Arnita et al., 2024; Susanto & Mahmudi, 2021). By understanding students' experiences directly, this research is expected to provide a more concrete picture for designing geometry instruction that is more contextual, adaptive, and meaningful. The research questions were as follows: (a) How are the categories formed related to students' difficulties in understanding geometry? (b) How are the themes formed related to students' difficulties in understanding geometry?

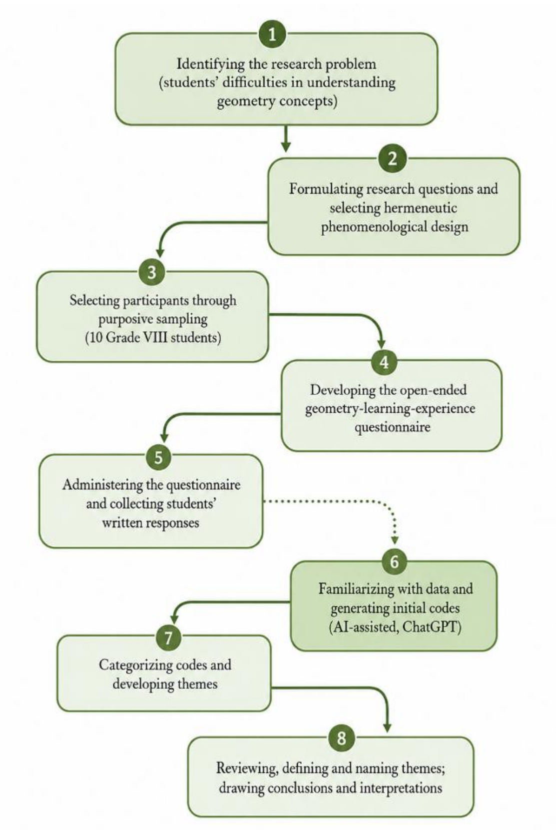
2. Method

2.1 Research Design

This study employed a hermeneutic phenomenological design, as it aimed to investigate in depth students' experiences in understanding geometry concepts. This approach was selected because it enabled the researchers to uncover the subjective meaning behind the learning difficulties encountered by students through interpretation of their narrative experiences (Ayu Putri Arnita et al., 2024; Kinanti et al., 2023). In the context of mathematics learning, this phenomenological approach allowed the exploration of cognitive and affective aspects that are often invisible in direct observation, particularly in relation to difficulties involving abstract and visual thinking. According to Susanto and Mahmudi (2021), this approach also creates space for students to articulate their learning challenges, especially those tied to the development of their geometric thinking in line with Van Hiele's theory.

The overall procedure of the study followed eight sequential stages, from problem identification to the interpretation of findings, as illustrated in Figure 1. This procedural flow was designed to ensure that the interpretive process remained systematic, transparent, and traceable from raw data to final themes, which is particularly important when part of the coding process is supported by an artificial intelligence tool, as described in the Data Analysis section. The advantage of this hermeneutic phenomenological design is that it offers a contextual and holistic understanding of geometry learning difficulties, rather than reducing students' struggles to a single test score.

Figure 1
Flow of the Research Design



2.2 Research Participants

The participants of this study were 10 eighth-grade students from a private junior high school in Mataram City, West Nusa Tenggara, Indonesia, selected through purposive sampling. The participants consisted of five males and five females between 13 and 15 years of age. This school was chosen because, based on initial observations, a considerable number of students experienced difficulties in understanding geometry material, particularly in imagining spatial and flat shapes, making it a relevant site to explore the phenomenon in depth. For confidentiality, participants are referred to in this article using the codes S1 to S10.

Grade VIII was chosen because at this stage students have started learning geometry more deeply and their thinking skills have also developed, so they were expected to provide more reflective answers; adolescence was also considered an appropriate stage for inviting students to share their learning experiences honestly and openly (Steinberg, 2005). According to Ayu Putri Arnita et al. (2024), many junior high school students are still in the early stages of geometric thinking according to Van Hiele's theory, which causes them difficulty when working on more complex geometry problems. It was therefore important to pay attention to students' cognitive development stage at this age so that the study's interpretation of their difficulties could be developmentally grounded rather than treated as a uniform, one-size-fits-all deficit.

2.3 Data Collection

The main instrument in this study was an open-ended questionnaire containing two open-ended questions designed to explore students' experiences during the geometry learning process. Students were given the opportunity to respond freely and reflectively based on their classroom experiences, both in terms of understanding the material and facing difficulties during the learning process. This open-ended format was considered appropriate because it could capture various forms of difficulty that students had encountered, both cognitively and emotionally. As explained by Lestari and Naila (2021), students often face challenges in learning geometry due to the demands of abstract thinking, which not all of them are able to handle directly; exploring students' direct experiences was therefore important so that the resulting recommendations could be more relevant and targeted.

Data collection was carried out in a single session during regular class hours, with the class teacher's permission, and followed the procedure summarized in Table 1. Students completed the questionnaire individually and in writing, with the researchers present to clarify the instructions when needed but without directing the content of the students' answers. The full set of student responses, together with the questionnaire instrument, is documented and retained by the researchers as the primary data source for the subsequent thematic analysis.

Table 1
Data Collection Procedure

Stage	Activity	Time Allocation	Output
1	Introduction and rapport building; explanation of study purpose and voluntary participation	10 minutes	Verbal assent from students
2	Distribution of the open-ended questionnaire and instructions	5 minutes	Questionnaire sheets distributed
3	Independent completion of the questionnaire by students	20 minutes	Written responses (S1-S10)

Stage	Activity	Time Allocation	Output
4	Collection and initial check of completeness of responses	5 minutes	Verified response set
5	Debriefing and closing	5 minutes	Confirmation of data readiness for analysis

2.4 Data Analysis

Data were analyzed using thematic analysis following Braun and Clarke’s (2006) six-phase framework: (1) familiarizing oneself with the data, (2) generating initial codes, (3) searching for categories, (4) reviewing and refining themes, (5) defining and naming themes, and (6) producing the report. This approach was selected because it is systematic, which made it easier to identify recurring patterns and organize them into coherent themes. During the familiarization phase, the researchers repeatedly read the students’ written responses to understand their meaning in depth. To support the coding and theme-exploration process, the researchers also used ChatGPT as an analytical aid: this AI-assisted output was treated as a draft only, and every candidate code was cross-checked line by line against the original student responses, revised, merged, or discarded by the researchers, so that the final coding scheme reflects the researchers’ own analytical judgment rather than an unreviewed AI output.

The six resulting initial codes were grouped into five categories based on similarity of meaning, and the categories were subsequently condensed into three main themes that best represented the core patterns in the data (see Results). To strengthen the trustworthiness of the analysis, the researchers engaged in investigator triangulation by independently reviewing the coding scheme and discussing discrepancies until consensus was reached, consistent with recommendations for establishing credibility, dependability, and confirmability in qualitative research (Nowell et al., 2017). An audit trail linking each theme back to its constituent categories, codes, and original student statements was maintained throughout, as presented in the Results section.

2.5 Ethical Clearance

This study was conducted in accordance with the ethical principles for research involving human participants, including minors. Prior to data collection, the researchers obtained institutional permission from the school and informed consent from the students’ parents/guardians, in addition to verbal assent from the student participants themselves. Participation was voluntary, and students were informed of their right to withdraw at any stage without consequence. All responses were anonymized using participant codes (S1-S10), and data were stored securely and used solely for academic research purposes. Ethical approval for this study was granted by LPPM Universitas Nahdatul Wathan.

3. Results

This section presents the findings of the thematic analysis conducted to answer the two research questions: (a) how the categories formed related to students’ difficulties in understanding geometry, and (b) how these categories combine to form the main themes. The presentation moves progressively from the raw initial codes, to categories, to final themes, and is followed by an in-depth narrative account of each theme.

Table 2
Initial Code Description

No.	Code	Description of Factors
1	KA1	Difficulty understanding the teacher's explanation
2	KA2	Lack of visualizations and learning tools
3	KA3	Difficulty understanding geometric formulas and shapes
4	KA4	Uninteresting learning delivery
5	KA5	Lack of contextual question implementation
6	KA6	Lack of confidence in solving problems

Note. This table presents the initial codes derived from students' written responses (KA1-KA6). Coding was used to standardize and simplify the qualitative data by grouping similar responses into concise, comparable units prior to categorization.

Table 2 presents six initial codes identified from the data, representing various factors that contribute to students' difficulties in learning geometry. The identified factors include difficulties in understanding teachers' explanations, limited use of visualizations and learning tools, challenges in understanding geometric formulas and shapes, uninteresting instructional delivery, insufficient use of contextual problems, and lack of confidence in solving problems. These initial codes provide a systematic basis for grouping related factors into broader categories and identifying key themes in the subsequent thematic analysis.

Table 3
Difficulty Factor Categories

No.	Category	Description	Constituent Codes
1	C1	Teacher factors and learning aids as barriers	KA1, KA2
2	C2	Complexity of geometric materials	KA3
3	C3	Uninteresting learning methods	KA4
4	C4	Low connection between concepts and reality	KA5
5	C5	Students' psychological factors	KA6

Note. Category C1 was derived from KA1 and KA2 because both relate to pedagogical aspects, in which the teacher's fluency in explanation needs to be supported by tools that facilitate the representation of geometry concepts. This table condenses the six initial codes into five broader categories based on the similarity of the underlying issues, providing a more systematic structure for developing the final themes.

Table 3 shows the categorization of the initial codes into five broader categories representing the main sources of students' difficulties in learning geometry. These categories encompass teacher and learning-aid barriers (C1), the complexity of geometric materials (C2), uninteresting learning methods (C3), limited connections between geometric concepts and real-life contexts (C4), and students' psychological factors (C5). This categorization consolidates related initial codes into conceptually meaningful groups, providing a clearer framework for identifying and interpreting the overarching themes emerging from the data.

Table 4

Main Research Result Themes

No.	Theme Code	Theme Description	Source Categories
1	T1	Pedagogical barriers and limited learning aids in geometry	C1, C3 (KA1, KA2, KA4)
2	T2	Complexity of geometry concepts as the main difficulty factor	C2 (KA3)
3	T3	Lack of contextual application and student confidence	C4, C5 (KA5, KA6)

Note. This table represents the final stage of thematic condensation, in which the five categories are consolidated into three overarching themes reflecting the core problems students face in learning geometry concepts.

The Table 4, presents three overarching themes derived from the integration of related categories and their constituent initial codes. The first theme (T1) highlights pedagogical barriers and limited learning aids, while the second theme (T2) emphasizes the inherent complexity of geometric concepts as a major source of students' difficulties. The third theme (T3) reflects the combined influence of limited contextual application of geometry and students' lack of confidence, indicating that learning difficulties are shaped by both instructional and student-related factors.

Theme 1: Pedagogical Barriers and Limited Learning Aids

The first theme, pedagogical barriers and limited learning aids, was derived from Categories C1 and C3, encompassing three of the six initial codes (KA1, KA2, KA4). Students described difficulty understanding the teacher's explanation (KA1), a lack of visualizations and learning tools to support that explanation (KA2), and learning delivery that they experienced as uninteresting (KA4). Taken together, these codes point to a source of difficulty that originates less from students' own cognitive capacity and more from the instructional environment surrounding them.

Students consistently connected the clarity of the teacher's explanation to the presence or absence of visual and concrete tools. Where explanations relied solely on verbal description or static text, several students reported losing track of how a shape or formula was meant to be visualized, which in turn made the material feel harder than it might otherwise have been. This pattern suggests that pedagogical barriers and limited learning aids are not two separate problems but two faces of the same difficulty: an explanation without adequate visual scaffolding is, for many students, functionally equivalent to no explanation at all when the content is as visually and spatially demanding as geometry.

This finding is consistent with the broader literature on visualization tools in geometry instruction, which shows that dynamic visual media can substantially improve students' conceptual and representational understanding when integrated into teaching rather than treated as optional supplements (Azizah et al., 2021; Bhagat & Chang, 2015). It also resonates with survey and design-based evidence indicating that when instruction depends heavily on rote explanation without corresponding representational support, students tend to disengage regardless of how conceptually able they are (Buckley et al., 2019). Notably, students did not describe these barriers as a reason to give up on geometry altogether; rather, several framed them as a specific, addressable gap, a signal that improving the availability of visual aids and interactive delivery could plausibly reduce this component of difficulty without requiring a wholesale redesign of the curriculum.

Theme 2: Complexity of Geometry Concepts

The second theme, the complexity of geometry concepts, was derived from a single but recurring category (C2), corresponding to initial code KA3: difficulty understanding geometric formulas and shapes. Although represented by only one initial code, this theme was retained as distinct because it reflects a source of difficulty intrinsic to the subject matter itself, separate from how it is taught or how confident students feel about it.

Students described geometry as demanding a kind of abstract, spatial thinking that other branches of school mathematics do not require to the same degree: recognizing a shape's properties, manipulating it mentally, and connecting a formula to what that formula actually represents in space. This is consistent with Van Hiele's theory of geometric thinking, which holds that understanding progresses through hierarchical levels, from visual recognition, to analysis of properties, to informal deduction, and eventually formal proof, and that a student who has not yet consolidated an earlier level will struggle with tasks that presuppose it (Ayu Putri Arnita et al., 2024; Susanto & Mahmudi, 2021). A systematic review of the Van Hiele model similarly concludes that difficulties with geometric content are closely tied to whether instruction matches a student's current developmental level of geometric thinking (Naufal et al., 2021).

This intrinsic complexity also aligns with cognitive research on spatial reasoning, which shows that geometric problem-solving draws on mental rotation, spatial visualization, and spatial orientation abilities that develop unevenly across students and are not automatically strengthened simply by more practice with formulas (Pittalis & Christou, 2010). For students whose spatial reasoning is still developing, geometry can therefore remain difficult even when their general mathematical ability is otherwise adequate.

Theme 3: Lack of Contextual Application and Student Confidence

The third theme, lack of contextual application and student confidence, was derived from Categories C4 and C5, corresponding to initial codes KA5 (lack of contextual question implementation) and KA6 (lack of confidence in solving problems). This theme combines two dimensions of difficulty that, on the surface, appear different, one concerning the relevance of the material, the other concerning students' self-belief, but that emerged from the data as closely intertwined.

Several students indicated that geometry problems presented in class felt disconnected from situations they recognized from daily life, which reduced their sense that the material was worth the effort of mastering. Other students described giving up on a geometry problem not because they lacked the necessary steps, but because they doubted their own ability to arrive at a correct answer before they had even attempted it. This pattern is consistent with research on mathematical self-efficacy, which shows that students' confidence in their own problem-solving ability is often a stronger predictor of performance than prior achievement or perceived usefulness of the material (Pajares & Miller, 1994), and with evidence that a lack of clarity about what a mathematics problem is actually asking, often worsened by unfamiliar, non-contextual phrasing, is itself a distinct source of difficulty (Tambychik & Meerah, 2010).

Read together, contextual disconnection and low confidence appear to reinforce one another: a student who cannot see the relevance of a geometry problem has less reason to persist through difficulty, and a student who lacks confidence is less likely to attempt the kind of exploratory, trial-and-error engagement that contextual problems typically require.

Integration of the Three Themes

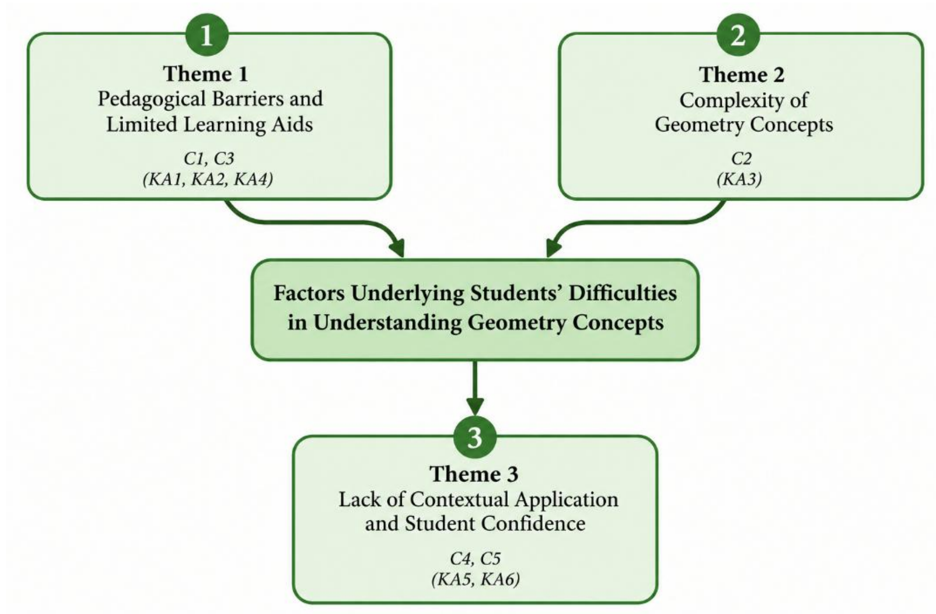
Figure 2 presents a thematic map summarizing how the six initial codes converge, through five categories, into the three main themes described above. Rather than being independent, the three themes appear to interact: pedagogical barriers and limited learning aids (Theme 1) make the intrinsic complexity of geometry (Theme 2) harder to overcome, since students are given fewer representational resources to compensate for content that is already cognitively demanding; at the same time, the resulting difficulty deepens the lack of confidence captured in Theme 3, which further reduces students' willingness to engage with contextual, exploratory tasks that could otherwise strengthen their spatial reasoning.

It is also worth noting the relative distribution of the themes within the dataset. Theme 1 and Theme 3 were each supported by two categories and multiple initial codes, suggesting that instructional and affective factors were at least as prominent in students' accounts as the intrinsic difficulty of the material itself (Theme 2). This distribution is consistent with thematic analysis guidance that a theme's importance should be judged by its conceptual centrality to the research question rather than by code frequency alone (Braun & Clarke, 2006; Nowell et al., 2017).

Answering the two research questions directly: with respect to RQ(a), the analysis identified five categories underlying students' difficulties in understanding geometry, teacher factors and learning aids as barriers, complexity of geometric materials, uninteresting learning methods, low connection between concepts and reality, and students' psychological factors. With respect to RQ(b), these five categories combined into three overarching themes, pedagogical barriers and limited learning aids, the complexity of geometry concepts, and the lack of contextual application and student confidence, which, taken together, depict students' difficulties in understanding geometry as a multidimensional phenomenon spanning instructional, cognitive, and affective dimensions rather than a single, isolated deficiency.

Taken as a whole, the pattern of findings across all three themes indicates that no single category of intervention, improving media alone, sequencing content by Van Hiele level alone, or building confidence alone, is likely to be sufficient on its own. Because the themes were shown to reinforce one another, the most plausible path toward reducing students' difficulties in understanding geometry is a coordinated one, in which instructional design, developmental sequencing, and psychological support are addressed together rather than treated as separate, competing priorities for classroom time.

Figure 2
Thematic Map of Factors Underlying Students' Difficulties in Understanding Geometry Concepts



4. Discussion

This study set out to explore, through a hermeneutic phenomenological lens, the factors underlying eighth-grade students' difficulties in understanding geometry concepts and how these factors combine into overarching themes. The findings revealed three interrelated themes — pedagogical barriers and limited learning aids, the complexity of geometry concepts, and the lack of contextual application and student confidence — which together suggest that geometry learning difficulties cannot be reduced to a single cause but instead reflect the interplay of instructional, cognitive, and affective dimensions of learning.

The first theme, pedagogical barriers and limited learning aids, is consistent with a substantial body of evidence on the instructional value of visual and concrete representations in geometry teaching. Geometry contains many abstract concepts and requires students to use visual imagination; the use of concrete or dynamic media is therefore considered essential so that students can gradually develop spatial understanding (Nuriah et al., 2025). This is corroborated by studies showing that limitations in instructional media can hinder students' ability to grasp basic geometry concepts (Mudhiah & Shodikin, 2019), and by evidence that pre-service and in-service teachers alike often struggle with geometry pedagogy when their own strategies are weak (Abdurrahman & Nofriyandi, 2022). The importance of visual tools is further supported by studies on cooperative, Van Hiele-based learning models, which show measurable improvements in problem-solving ability when accompanied by suitable media (Fitry Burais, 2018), and by evidence that problem-based learning combined with dynamic geometry software such as GeoGebra meaningfully strengthens students' conceptual understanding (Azizah et al., 2021; Bhagat & Chang, 2015; Mudhiah & Shodikin, 2019).

The second theme, the complexity of geometry concepts, aligns closely with Van Hiele's theory of geometric thinking, which holds that understanding progresses through hierarchical levels from visualization to formal deduction, and that students who have not reached the level a task presupposes will struggle regardless of effort (Ayu Putri Arnita et al., 2024; Susanto & Mahmudi, 2021). This is reinforced by evidence that Indonesian junior high school students' spatial abilities are, on average, still relatively low, which requires gradual and level-appropriate instructional approaches (Susanto & Mahmudi, 2021), and by findings that high school students' mastery of geometry varies significantly according to their cognitive stage (Didaktik Matematika Roskawati et al., 2015). A systematic review of the Van Hiele model similarly found that geometry instruction is most effective when explicitly matched to students' current thinking level and supported by metacognitive scaffolding (Naufal et al., 2021), while Sulistiowati et al. (2019) and Papadam and Agaliotis (2021) both report that geometric problem-solving difficulties, including among students with additional learning needs, are strongly tied to underlying Van Hiele levels. These findings collectively suggest that the complexity students experience is not merely a matter of insufficient effort but reflects a genuine developmental mismatch between task demands and current thinking level — a mismatch also documented in cognitive research on spatial reasoning more broadly (Pittalis & Christou, 2010).

The third theme, the lack of contextual application and student confidence, relates to two constructs that the mathematics education literature increasingly treats as intertwined. Mathematics learning connected to real-world or cultural contexts has been shown to improve both understanding and engagement (Hendriyanto et al., 2021), while a lack of real-life connection to geometric literacy problems has been linked directly to persistent difficulty (Dian Angriani & Tampa, 2022). Confidence, meanwhile, functions as more than a secondary emotional factor: self-efficacy beliefs have been shown to predict mathematical problem-solving performance more strongly than prior achievement, perceived usefulness of the material, or gender (Pajares & Miller, 1994), and difficulty interpreting what a problem is actually asking — a difficulty compounded when problems are abstract rather than contextual — has itself been identified as a distinct barrier to mathematical problem-solving (Tambychik & Meerah, 2010). Nurjanah and Juliana (2020) similarly found that students' spatial perception significantly affects their performance in geometry problem-solving, reinforcing the interpretation that confidence and contextual relevance jointly shape whether students persist through geometric difficulty or disengage from it. The value of examining these psychological dimensions through direct engagement with students' own accounts, rather than through achievement data alone, is further supported by foundational discussions of the phenomenological method in the social sciences (Giorgi, 2008).

Read together, these three themes support the interpretation that students' difficulties in understanding geometry in this study reflect a mutually reinforcing structure rather than three independent problems: limited pedagogical support leaves the material's intrinsic complexity unmitigated, and the resulting experience of struggle erodes the confidence and sense of relevance that would otherwise sustain engagement with contextual, exploratory tasks. This integrated reading extends earlier, more fragmented accounts of geometry-specific difficulties by showing, through students' own first-person accounts and consistent with recent methodological guidance on rigorous thematic analysis, how instructional, cognitive, and affective factors are experienced as an interconnected whole (Braun & Clarke, 2006; Nowell et al., 2017).

These findings carry several practical implications for classroom practice. First, because pedagogical barriers and limited learning aids emerged as a prominent theme, teachers may benefit from systematically incorporating visual and manipulative tools — including dynamic geometry software where available — rather than relying primarily on verbal or textual explanation. Second, given that difficulty was closely tied to students' Van Hiele level, instruction sequenced explicitly around visualization, analysis, and informal deduction, rather than jumping directly to formal proof or formula application, is likely to reduce the developmental mismatch identified in Theme 2. Third, because contextual disconnection and low confidence reinforced one another in students' accounts, embedding geometry in recognizable real-world or cultural contexts, combined with scaffolding and positive reinforcement strategies that build students' sense of competence, may address both the motivational and cognitive dimensions of the difficulty simultaneously.

This study is not without limitations. The number of participants (n = 10) and the single-school setting limit the transferability of the findings to other populations, and the reliance on a single open-ended questionnaire, rather than triangulated methods such as interviews or classroom observation, constrains the depth of interpretation that hermeneutic phenomenology ideally affords. In addition, although the initial coding stage was assisted by an AI tool and subsequently verified manually by the researchers, the use of AI in qualitative coding remains a relatively new practice whose implications for interpretive rigor continue to be debated in the methodological literature (Perkins & Roe, 2024). Future research could address these limitations by incorporating semi-structured interviews or classroom observations, expanding the sample across multiple schools, and evaluating targeted pedagogical interventions, particularly Van Hiele-aligned, visually supported, and contextually grounded instruction, designed to interrupt the reinforcing cycle identified in this study.

5. Conclusion

This study explored the factors underlying eighth-grade students' difficulties in understanding geometry concepts through a hermeneutic phenomenological design combined with thematic analysis. Based on the analysis of open-ended questionnaire responses from ten students, three main themes were identified: (1) pedagogical barriers and limited learning aids, (2) the complexity of geometry concepts, and

(3) the lack of contextual application and student confidence. These themes were found to be interrelated rather than independent, reflecting a mutually reinforcing structure in which instructional, cognitive, and affective factors jointly shape students' experience of learning geometry. The findings suggest that improving students' understanding of geometry requires more than remedial content instruction; it calls for instructional approaches that align with students' Van Hiele levels of thinking, make deliberate use of visual and interactive media, embed geometric content in contextual and real-world applications, and build student confidence through scaffolding and supportive classroom environments. Future intervention studies are recommended to test such approaches and to examine their effect on students' understanding of geometry across broader and more diverse school settings.

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Author Contribution

Conceptualization: R.A., M.R.; Methodology: R.A., S.B.; Data curation and formal analysis: R.A., M.R.; Investigation: R.A.; Writing – original draft preparation: R.A.; Writing – review and editing: M.R., S.B.; Supervision: S.B. All authors have read and agreed to the published version of the manuscript.

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Conflict of Interest

The authors declare no conflict of interest.

AI Declaration

During the data analysis stage of this study, the authors used ChatGPT (OpenAI) as an analytical aid to help generate initial candidate codes from the qualitative questionnaire data. All AI-generated output was subsequently reviewed, verified, corrected, and finalized by the authors, who take full responsibility for the accuracy and interpretation of the reported findings. Generative AI was not used to draft the manuscript's narrative text, to design the study, or to draw its scientific conclusions.

Data Availability

The datasets analyzed in this study, comprising anonymized responses to the open-ended questionnaire, are available from the corresponding author upon reasonable request. Because participants were minors, raw response transcripts are not publicly archived in order to protect participant privacy and confidentiality.

6. References

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