



## Analysis of spatial literacy in grade V volume material reviewed from learning style

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### ABSTRACT

The background of this study is the importance of spatial literacy skills in understanding the concept of three-dimensional geometry, as well as differences in students' learning style preferences in processing information. This study aims to determine the spatial literacy skills of grade V elementary school students on volume material in terms of visual, auditory, and kinesthetic learning styles. This research uses a descriptive qualitative approach with the subject of three students who each represent visual, auditory, and kinesthetic learning styles, and have high academic abilities. The instruments used were the learning style questionnaire, the spatial literacy test, and the interview guidelines. The time triangulation technique was used to ensure the validity of the data, and the analysis was conducted using the Miles and Huberman model. The results showed that students with visual learning styles excelled in the visualization and communication domains, auditory students stood out in spatial reasoning. In contrast, kinesthetic students showed low achievement in all three domains. The findings indicate that learning styles influence spatial literacy achievement and the importance of learning approaches that are adaptive to students' learning characteristics.

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### ABSTRAK

Latar belakang penelitian ini adalah pentingnya kemampuan literasi spasial dalam memahami konsep geometri tiga dimensi, serta adanya perbedaan preferensi gaya belajar peserta didik dalam memproses informasi. Penelitian ini bertujuan untuk mengetahui kemampuan literasi spasial peserta didik kelas V sekolah dasar pada materi volume ditinjau dari gaya belajar visual, auditori, dan kinestetik. Penelitian ini menggunakan pendekatan deskriptif kualitatif dengan subjek tiga peserta didik yang masing-masing mewakili gaya belajar visual, auditori, dan kinestetik, serta memiliki kemampuan akademik tinggi. Instrumen yang digunakan berupa angket gaya belajar, tes literasi spasial, dan pedoman wawancara. Teknik triangulasi waktu digunakan untuk menjamin keabsahan data, dan analisis dilakukan dengan model Miles dan Huberman. Hasil penelitian menunjukkan bahwa peserta didik dengan gaya belajar visual unggul dalam domain visualisasi dan komunikasi, peserta didik auditori menonjol dalam penalaran spasial, sedangkan peserta didik kinestetik menunjukkan capaian yang rendah pada ketiga domain. Temuan ini mengindikasikan bahwa gaya belajar berpengaruh terhadap capaian literasi spasial dan pentingnya pendekatan pembelajaran yang adaptif terhadap karakteristik belajar peserta didik.

**Kata Kunci:** gaya belajar; literasi spasial; volume

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## **INTRODUCTION**

Mathematics is often stigmatized as a boring, difficult, and monotonous subject, particularly among elementary school students. This perception is reinforced by the belief that mathematics is an abstract science that can only be mastered by students with high intelligence (Dewi *et al.*, 2024; Putri *et al.*, 2019). Mathematics is frequently regarded as a frightening or hard-to-learn subject because students find it challenging to understand or are unaware of its concepts. Many students express that "mathematics is difficult," reflecting frustration due to low conceptual understanding, exam pressure, and the lack of variety in teaching methods (Budiyani *et al.*, 2021; Rostiana & Wahyudin, 2025). Learning difficulties in mathematics become increasingly evident when students are confronted with spatial geometry, particularly concerning the volume of cubes and rectangular prisms. The level of difficulty in understanding geometric material, especially polyhedra with flat faces, remains relatively high (Alfianti & Nalurita, 2025).

Common errors include mistakes in performing multiplication operations, difficulties understanding word problems, and an inability to identify key information in the problems (Heryanto *et al.*, 2022; Setiyanto *et al.*, 2021). Weaknesses in these basic skills are the primary obstacles to mastering the concept of volume. Furthermore, students also face challenges in transforming verbal information into spatial representations, which is the essence of spatial literacy. This literacy requires students to visualize and manipulate geometric shapes in three-dimensional space, a skill that is difficult to achieve without a strong conceptual foundation. These issues become increasingly complex when considering the diversity of students' learning styles. Essentially, individuals differ from one another, and similarly, each student in the classroom possesses unique characteristics (Andriani & Nugraheni, 2024).

Each individual has different learning preferences, such as visual, auditory, or kinesthetic styles, which influence how they receive and process information. Unfortunately, most classroom learning approaches have not optimally accommodated these differences, resulting in disparities in learning outcomes. Based on interviews with fifth-grade teachers at an elementary school in Jakarta, it was found that limited instructional time is the main obstacle to reinforcing the material. Teachers reported that the available time does not allow for reviewing or deepening topics that students have not yet understood. As a result, many students still struggle to fully and continuously grasp the concept of volume. Several previous studies have highlighted the importance of spatial literacy in Mathematics education.

Previous studies have shown that errors in using formulas and difficulties in visualizing three-dimensional shapes are concrete manifestations of students' low spatial literacy (Purba, 2022). Earlier research also emphasizes that spatial ability is closely related to visual perception and mental manipulation of spatial objects (Amri & Kusuma, 2021; Sari *et al.*, 2023). Other studies found that although students may demonstrate indicators of spatial visualization and reasoning, many still exhibit weaknesses in spatial communication (Mas'udah *et al.*, 2021). However, most of these studies were conducted at the secondary school level (junior and senior high schools) and have not specifically examined the

relationship between learning styles and spatial literacy in the context of volume material among fifth-grade elementary school students.

Based on this gap, the present study offers scientific novelty by analyzing spatial literacy among elementary school students in volume material, with particular attention to their learning styles, which have not been widely explored, particularly at the fifth-grade level. This study specifically examines the spatial literacy abilities of fifth-grade elementary school students in understanding volume materials, considering different learning styles. The objective of this research is to analyze the spatial literacy skills of fifth-grade students in the volume of cubes and rectangular prisms, from the perspective of learning styles. Through this study, it is expected to provide a comprehensive overview of the challenges students face in mastering volume concepts, while also offering insights for teachers to develop adaptive teaching strategies based on students' learning characteristics.

## LITERATURE REVIEW

### Definition of Literacy

Literacy is a fundamental ability that encompasses skills in reading, writing, speaking, and comprehending information to solve various problems in daily life (Oktariani & Ekadiansyah, 2020). Literacy is not only about technical reading and writing, but also involves critical thinking in accessing and utilizing written, visual, and digital information (Riyanto, 2023). In the era of the Fourth Industrial Revolution, literacy skills have become increasingly crucial as they help individuals adapt to technological changes and use information intelligently. Literacy also plays a role in developing other skills, such as problem-solving, communication, and decision-making (Fahrianur *et al.*, 2023).

Literacy plays a crucial role in supporting individuals' critical thinking and adaptation to the era's dynamics. This indicates that literacy is not merely a basic skill but also serves as a foundation for developing 21st-century competencies required in personal, social, and professional life. In the context of primary education, literacy serves as a fundamental basis for cross-disciplinary understanding. Reading and writing activities at the elementary level are not only aimed at recognizing symbols and words but also at developing the ability to comprehend meaning and express ideas both in written and oral forms. Strong literacy from an early age will support cognitive and social development in students and serve as a foundation for building conceptual understanding, including in Mathematics learning and spatial skills (Fahrianur *et al.*, 2023).

### Mathematical Literacy

Mathematical literacy is a fundamental ability that encompasses the skills to develop, apply, and understand mathematical concepts and procedures in various contexts (Matondang *et al.*, 2023). This literacy not only involves technical proficiency, such as calculation and formula use, but also the capacity to reason logically, articulate mathematical ideas clearly, and utilize various visual, symbolic, and verbal representations to convey mathematical information (Sari, 2024). Mathematical literacy plays a crucial role in mathematics learning,

as individuals in daily life are constantly faced with situations that require the ability to solve mathematical problems (Kholifasari *et al.*, 2020). Through mathematical literacy, individuals can describe, explain, and predict phenomena based on their mathematical understanding. Mathematical literacy is closely related to contextual problems arising from real-life situations (Jannah & Hayati, 2024; Zahrah, 2024).

Within the PISA framework, mathematical literacy is defined as an individual's capacity to formulate, employ, and interpret mathematics to solve problems in a variety of real-life contexts. This literacy encompasses mastery of mathematical concepts, procedures, facts, and tools necessary to understand the role of mathematics in social life, while also enabling individuals to make logical, reflective, and responsible decisions as 21st-century citizens. Mathematical literacy connects mathematics to everyday life, such as budgeting, reading graphs, and interpreting statistical data. These skills support critical thinking, data-driven argumentation, and rational decision-making, thus serving as a foundational component of 21st-century competencies such as problem-solving, communication, and collaboration (Lindawati, 2018; Manoy & Sari, 2020). Mathematical literacy includes three main domains: spatial literacy, numeracy, and quantitative literacy. Spatial literacy relates to understanding three-dimensional objects and visual transformations; numeracy involves processing numbers and evaluating data; and quantitative literacy pertains to concepts of change, variable relationships, and uncertainty (Sikko, 2023).

### **Spatial literacy**

Spatial literacy is the ability to think spatially that enables individuals to understand and interpret the relationships among objects in space, as well as to act effectively within their surrounding environment. This literacy supports daily activities such as navigation, spatial problem solving, and design. According to Gardner's theory of multiple intelligences, visual-spatial intelligence reflects the ability to comprehend information through visualization and imagination, which plays an important role in mathematics and science learning (Sutarna & Maryani, 2021). Mathematical spatial ability refers to the competence in visualizing, comparing, estimating, determining, constructing, and representing information from visual stimuli within a spatial context (Ifanda *et al.*, 2017).

This ability is applied in various non-academic situations, such as reading maps and understanding directions, as well as integrating visual, cognitive, and communication skills (Kustiawati *et al.*, 2023; Setiani & Rafianti, 2018). In mathematics, particularly in geometry, spatial literacy is crucial because it relates to the representation of shapes and space, and contributes to various professions such as architecture and engineering. However, this skill is still rarely explicitly identified in the curriculum, even though it is essential for enhancing understanding of geometric concepts and for interacting effectively with the environment (Ningsih *et al.*, 2021).

### **Volume Material for Grade V**

A three-dimensional shape is a geometric form with volume or capacity, bounded by surfaces composed of points on its faces. Three-dimensional shapes are classified into two types:

polyhedral shapes with flat faces (such as cubes, rectangular prisms, prisms, and pyramids) and shapes with curved surfaces (such as cylinders, cones, and spheres). Each three-dimensional shape has its own properties and formulas for calculating its surface area and volume. A cube is a three-dimensional shape bounded by six congruent square faces and is commonly found in everyday life, such as in dice or cardboard boxes. Meanwhile, a rectangular prism resembles a cube but is bounded by six rectangular faces that are paired and congruent, as seen in cabinets and aquariums.

The volume of a three-dimensional shape indicates how much space it occupies. In the context of basic mathematics education, volume is usually calculated using unit cubes. The volume of a cube is calculated by raising the length of its side to the third power ( $V = S^3$ ), whereas the volume of a rectangular prism is calculated using the formula ( $V = l \times w \times h$ ). This concept of volume calculation can be visualized through activities that involve arranging unit cubes into a specific three-dimensional shape, then counting the total number of units to determine the volume concretely. This approach facilitates students' understanding of volume concepts through visual and contextual examples. Geometry learning is closely related to students' ability to understand the relationships between objects and space, a form of spatial intelligence (Sya'bani *et al.*, 2023).

## Learning Styles

Each student has a diverse learning style, which refers to how an individual receives, processes, and organizes information. Learning styles play a role in three stages of the learning process: receiving new information, processing it, and storing it for future use. Learning styles influence the initial reception of information through its understanding and meaning (Hisnil Ain *et al.*, 2023). The visual learning style relies on the sense of sight to absorb information. Students with this style tend to be attracted to familiar visual displays and easily remember elements such as motion, color, shape, and size. In contrast, the auditory learning style emphasizes the sense of hearing. Students with this type comprehend information more easily through listening activities, such as engaging with audio materials, lectures, discussions, or debates, and generally learn through hearing and speaking. Meanwhile, the kinesthetic learning style prioritizes direct involvement, such as through movement, touch, emotions, or physical experiences. Students with this style learn more effectively when actively engaged in physical activities and direct interactions (Hassan *et al.*, 2021).

## METHODS

This study is a descriptive, qualitative research study. This approach was chosen because the main objective of the research is to describe students' spatial literacy abilities in solving volume problems, based on variations in students' learning styles, namely Visual, Auditory, and Kinesthetic (VAK). A qualitative approach was employed because the study focuses on understanding the natural conditions of the research subjects, without any experimental treatment or manipulation. The research was conducted at an elementary school located in South Jakarta. The selection of this school was based on interviews with the class teacher,

who revealed that students' ability to handle the volume of material was still relatively low. In addition, the researchers also considered that the volume topic had previously been taught to the students.

The research subjects were three fifth-grade students in the 2024/2025 academic year, each representing one of the VAK learning styles. All three subjects were female students with relatively comparable high academic abilities. They were selected as subjects because they exhibited different learning styles and demonstrated high competence. This was determined from responses to a questionnaire that identified each student's learning style. Once the subjects were determined, they were administered an initial spatial literacy test designed according to relevant indicators. If the results of the first test were inconsistent, a second test was given, and, if necessary, a third to ensure consistent responses.

Data collection was conducted using four methods: interviews and documentation of the odd semester Mathematics final exam scores. The instruments included questions on learning style identification, spatial literacy test items, and interview guidelines. The data collected in this study consisted of interview data aimed at exploring students' understanding of spatial literacy. The study employed a time triangulation technique as a credibility check to ensure data validity. Data were analyzed using the Miles and Huberman model, which comprises the stages of data reduction, data display, and conclusion drawing.

## **RESULTS AND DISCUSSION**

In addition to using the learning style questionnaire as a reference, the selection of research subjects also took into account students' odd-semester Mathematics final exam scores. These scores served as an additional indicator to identify students with high mathematical ability. Thus, the research subjects were selected not only for their learning styles but also for their strong academic performance in Mathematics.

**Table 1.** Final Exam Grades for Odd-Semester Subjects

<b>No.</b>	<b>Subject</b>	<b>Scores</b>
1.	SV	90
2.	SA	90
3.	SK	85

*Source: Homeroom Teacher of Grade V*

Based on the documentation in **Table 1** of the odd-semester Mathematics exam scores, data were obtained from the three subjects: SV, SA, and SK.

### **Visual Learning Style Student (SV)**

Question number 1: In the first triangulation, SV depicted a combination of a cube and a rectangular prism and presented the net of the rectangular prism with correct dimensions, but the drawing was not proportional. In the second triangulation, SV again gave a similar answer by drawing the combination of a cube and a rectangular prism along with a complete

cube net, although still not proportional. Therefore, SV was consistent in answering question number 1, and the answer was categorized as correct.

Question number 2, in the first triangulation, SV drew an enlarged rectangular prism with the correct dimensions, but the drawing was not proportional. A similar situation occurred in the second triangulation, where SV correctly enlarged the height of the rectangular prism, but again did not draw it proportionally. SV demonstrated consistency in answering question number 2, with the answer categorized as correct.

Question number 3, in the first triangulation, SV drew only a single small cube, whereas a rectangular prism composed of 12 unit cubes arranged in three layers was required. In the third triangulation, SV drew a square with another square inside, which did not represent a rectangular prism constructed from unit cubes. Thus, SV consistently responded to this question with the same pattern; however, the answer was categorized as incorrect.

Question number 4, in the first triangulation, SV answered that the volume of a rectangular prism could be calculated using unit cubes and stated the relationship as "1 rectangular prism equals 6 unit cubes." In the third triangulation, SV again stated that the volume of a rectangular prism is calculated from the volumes of unit cubes, but did not explicitly explain the relationship. SV's answers remained somewhat inaccurate yet consistent, and were therefore categorized as partially correct.

Question number 5, in the third triangulation, SV correctly calculated the volumes of the cube and the rectangular prism and accurately compared them. In the fourth triangulation, SV again gave a correct answer in accordance with the concept of volume comparison. SV showed consistency, and the answer was categorized as correct.

In the third triangulation, SV correctly calculated the volumes of the cube and the rectangular prism and determined the dimensions of the rectangular prism that needed to be changed so that its volume equaled the cube's volume. The same was observed in the fourth triangulation, where SV again demonstrated a good understanding of the relationship between volume and dimensions. The answers were consistent and categorized as correct.

In the first triangulation, SV accurately stated the mathematical notation for the rectangular prism dimensions, correctly divided the dimensions, and provided a logical reason. In the third triangulation, SV again answered correctly, stating the notation and dividing the dimensions accurately, and included a rationale. SV demonstrated consistency with answers categorized as correct.

Question number 8, in the first triangulation, SV determined the correct shelf choice based on the problem and provided a logical reason. A similar pattern was observed in the third triangulation, where SV again selected the correct shelf and gave an appropriate rationale. SV demonstrated consistency, with answers categorized as correct.

Question number 9, in the first triangulation, SV answered without showing the volume calculation process, and the response was incorrect. In the second triangulation, SV again answered incorrectly, omitting the steps to calculate the combined volume. Thus, SV demonstrated consistency, but the answer was categorized as incorrect.

Question number 10, in the first triangulation, SV concluded that both shelves have the same volume. In the second triangulation, SV stated that the combined volume of boxes A

and B is 189 units, as required by the problem. The answer was consistent and categorized as correct.

SV successfully met two out of three indicators in the spatial literacy visualization domain. She demonstrated the ability to sketch spatial objects through visual representations that align with the problem and to develop visualizations to facilitate problem-solving. However, SV was unable to meet the indicator for transforming visual representations of objects into different representations. In the reasoning domain, SV also met only two out of three indicators, specifically in comparing and managing spatial concepts and relationships. However, she did not yet demonstrate the ability to analyze spatial concepts and object relationships in depth. Meanwhile, in the communication domain, SV met three of the four indicators. She could identify the information provided in the problem, convey ideas regarding objects or spatial relationships accurately both orally and in writing, and draw correct conclusions from her work. Nevertheless, SV had not yet mastered the indicator related to the appropriate use of mathematical terms, notations, and symbols for objects or spatial relationships.

### **Auditory Learning Style Student (SA)**

Question number 1, in the third triangulation, SA accurately depicted a combination of a cube and a rectangular prism, along with the prism's net. However, the drawing was not proportional and lacked measurements. The same was observed in the fourth triangulation, where SA again represented the shapes correctly, but still without measurements and with a non-proportional drawing. The answer is categorized as correct.

Question number 2, in the first triangulation, SA drew a rectangular prism enlarged on all sides, whereas only the width of the prism should have been adjusted. In the second triangulation, SA also failed to depict the prism's enlarged dimensions accurately. Both responses demonstrate inaccuracy and consistent errors on this question.

Question number 3, during the first triangulation, SA did not transform the rectangular prism into three layers composed of 12 unit cubes; she continued to draw the prism as before. In the second triangulation, SA again did not convert the prism into a four-layer arrangement of 12 unit cubes, drawing it as before. Both responses demonstrate consistency and are categorized as incorrect.

Question number 4, SA uses the cuboid volume formula and explains the relationship between volume and unit cubes accurately, both in the third and fourth triangulations. SA shows consistency with the answer categorized as correct.

Question number 5, in the first and second triangulations, SA made an error in calculating the volume of a cuboid and a cube, but was able to compare their volumes correctly. SA showed consistency in her answers with a partially correct category.

Question number 6, SA correctly calculated the volume and determined the dimensional changes of the rectangular prism to match the cube's volume, both in the third and fourth triangulations. SA demonstrated consistency, with answers categorized as correct.

Question number 7, SA divided all dimensions of the rectangular prism in the first and second triangulations, whereas only the height should have been adjusted. She also did not justify. SA demonstrated consistency, with answers categorized as partially correct.

Question number 8, in the first triangulation, SA determined the correct shelf choice based on the problem and provided a logical reason. A similar pattern was observed in the second triangulation, in which SA again selected the correct shelf and provided an appropriate rationale. SA demonstrated consistency, with answers categorized as correct.

Question number 9, SA only wrote the method for calculating volume, without completing the total combined volume, in both the second and third triangulations. The answers were incomplete and showed consistency, categorized as partially incorrect.

Question number 10, in the first triangulation, SA answered incorrectly, concluding that box B is larger than box A. In the second triangulation, SA again answered incorrectly, concluding that box B is larger than box A. Thus, SA was consistent in answering question 10 in both the first and second triangulations, with the answer categorized as incorrect.

SA met only one of three indicators of spatial literacy in the visualization domain. She demonstrated the ability to sketch spatial objects through visual drawings adapted to the given problem. However, SA was not yet able to develop these visualizations to support problem-solving, nor did she show the ability to transform visual forms of objects into other representations. In the reasoning domain, SA achieved two of the three indicators. She could analyze and manage spatial concepts and relationships, but was not yet able to compare them effectively. Meanwhile, in the communication domain, SA met only one of four indicators: the use of appropriate mathematical terms, notation, and symbols relevant to spatial objects or relationships. The other three indicators were not met, including the ability to identify information in the problem, express ideas about spatial objects orally or in writing, and draw correct conclusions from the completed work.

### **Kinesthetic Learning Student (SK)**

Question number 1, in the first triangulation, SK answered correctly. She illustrated a combination of a cube and a rectangular prism, along with the prism's net, with accurate dimensions. However, the drawing was not proportional. A similar result was observed in the second triangulation. SK again correctly illustrated the combination of the cube and the prism, along with the prism's net, but it remained non-proportional. SK demonstrated consistency with correct answers in both triangulations.

Question number 2, in the first triangulation, SK correctly enlarged the rectangular prism, particularly the height dimension, although the drawing was not proportional. In the second triangulation, she again correctly enlarged the prism's dimensions, but it remained non-proportional. SK demonstrated consistency with correct answers in both triangulations.

Question number 3, in the first triangulation, SK answered incorrectly, as she drew only a single cuboid, whereas she was supposed to draw an arrangement of 12 unit cubes in three layers. In the second triangulation, SK was also incorrect because she only drew a rectangle, not a cuboid. SK demonstrated consistency in her errors across both triangulations, with the answers categorized as incorrect.

Question number 4, in the second triangulation, SK provided an incorrect answer by writing only "by calculating" and stating that the volume relationship between the cube and the cuboid was "almost the same." In the third triangulation, she again answered incorrectly by mentioning " $s \times s \times s$ " for the cube and " $l \times w \times h$ " for the cuboid. However, she did not correctly explain the spatial relationship. Thus, SK consistently provided incorrect answers for this question.

Question number 5, in the second and third triangulations, SK answered incorrectly. She wrote the method for calculating the volume of both the cuboid and the cube, but the final answers were incorrect as well. SK demonstrated consistency in errors across both triangulations.

Question number 6, in the first triangulation, SK answered fairly well by correctly stating the dimensions of the cuboid that needed adjustment. However, she did not include the calculation steps. In the third triangulation, she again correctly identified the dimensions that needed adjustment, but did not explain the magnitude of the required changes or show the volume calculations. SK demonstrated consistency with a fairly adequate answer.

Question number 7, in the first triangulation, SK stated the mathematical notation for the cuboid's dimensions but divided all dimensions by 2. In contrast, only the height of the cuboid should have been halved. She also did not provide any reasoning. A similar situation occurred in the third triangulation, where SK again mentioned the mathematical notation but incorrectly divided the cuboid's dimensions without providing reasoning. SK demonstrated consistency with a fairly correct answer.

Question number 8, in the first triangulation, SK answered correctly by selecting the rack that matched the problem's context and providing a logical justification. In the third triangulation, she again demonstrated consistency with a correct answer.

Question number 9, in the first triangulation, SK provided an incorrect answer, both in calculating the volume and in using the formula. In the second triangulation, she again answered incorrectly, although she attempted to explain the method for calculating the combined volume. SK demonstrated consistency with an incorrect answer.

Question number 10, in the first triangulation, SK answered incorrectly, stating that it was "easy to understand." In the second triangulation, she wrote only "box B," without further explanation. SK demonstrated consistency with an incorrect answer.

SK achieved only two of three indicators of spatial literacy in the visualization domain. She met the indicators for developing visual representations to aid problem-solving and for sketching spatial objects based on the given problems. However, SK did not meet the indicator for transforming visual representations of objects into different representations. Meanwhile, in the reasoning domain, SK did not fulfill all spatial literacy indicators. She did not demonstrate the ability to analyze, compare, and manage spatial concepts and relationships optimally. In the communication domain, SK met only one of the four existing indicators: expressing ideas about spatial objects or relationships correctly, both orally and in writing. The three remaining unmet indicators included the ability to identify information from the problem, correctly use mathematical terms, notations, and symbols, and present the conclusions of the work accurately.

## Discussion

The study's results indicate variation in achievement on spatial literacy indicators across the three main domains (visualization, reasoning, and communication) by students' learning styles. SV (visual learning style) demonstrated relatively strong achievement in the visualization and communication domains, whereas SA (auditory) tended to perform better in reasoning, and SK (kinesthetic) showed generally lower achievement overall. This reflects that learning styles influence how individuals understand and process spatial information, as supported by the view that spatial ability is an intelligence that develops from an individual's interaction with the environment and can be enhanced through learning approaches that align with students' characteristics (Sutarna & Maryani, 2021). Previous studies emphasize that spatial literacy involves cognitive processes ranging from observing to communicating two- or three-dimensional objects, making it a critical skill in education, technology, art, and design (Mas'udah et al., 2021).

In the visualization domain, SV and SK met two of the three indicators, namely creating sketches and developing visual representations to solve problems. However, they were not able to transform the shapes of spatial objects. SA was only able to fulfill one indicator. This indicates that difficulties in visual transformation are a common obstacle for students. Challenges in understanding visual-spatial objects become a significant issue in elementary mathematics learning, particularly when students are required to represent changes in geometric shapes within two- and three-dimensional contexts (Amanda et al., 2024).

Perbedaan performa peserta didik juga terlihat pada domain penalaran. SV dan SA mampu memenuhi dua indikator, yaitu menganalisis serta mengelola konsep dan hubungan spasial. Meanwhile, SK was unable to meet any of the indicators. This highlights the importance of a strong conceptual understanding to support spatial reasoning. This limitation is also noted in other studies, which report that a lack of abstract reasoning about spatial relationships is associated with students' ability to comprehend non-visible mathematical ideas, particularly in the context of concrete operations at the elementary school level (Amanda et al., 2024).

In the communication domain, SV demonstrated the best performance, meeting three out of four indicators. Meanwhile, SA and SK each met only one indicator. This suggests that visual learners tend to be better at communicating spatial ideas through drawings or symbols, but are not yet optimal in the use of accurate mathematical notation and terminology. Spatial communication skills are an important aspect of developing spatial literacy, as they help students transform spatial understanding into verbal, written, and symbolic forms that others can understand (Sutarna & Maryani, 2021).

Another important finding is the significant individual variation. For instance, although SV excelled in communication, she still faced challenges in spatial reasoning. Similarly, SA performed fairly well in reasoning but showed lower ability in communication. This underscores that traditional classroom approaches are insufficient to improve spatial literacy evenly. Differentiated strategies that consider individual learning styles and strengths are necessary. Other studies also highlight the importance of using concrete media and interactive approaches to accommodate diversity in learning Mathematics at the elementary school level (Amanda et al., 2024).

Overall, the results of this study support previous findings on individual differences in spatial ability and highlight the importance of personalized learning approaches. However, the novel contribution of this research lies in providing a more detailed mapping of indicator achievements across each domain based on students' learning styles. This demonstrates that spatial literacy is influenced not only by cognitive ability but also by learning style, task context, and the learning stimuli provided.

## **CONCLUSION**

This study indicates that fifth-grade students' spatial literacy skills in the volume topic are uneven and are strongly influenced by each individual's learning style. Not all students can meet all indicators across the domains of visualization, reasoning, and communication. This suggests that developing spatial literacy still requires a more targeted learning approach that aligns with students' learning characteristics. Visual learners excel at visual representation and communication but struggle with transforming shapes and using mathematical symbols. Auditory learners demonstrate stronger spatial reasoning, while kinesthetic learners tend to face difficulties across nearly all domains. These findings underscore the importance of contextual, manipulative, and visual-based learning to support the comprehensive development of students' spatial literacy. Based on the results of this study, it is recommended that teachers identify students' learning styles from the outset as a foundation for designing more adaptive teaching strategies. Furthermore, the development of instructional media and learning materials that support spatial literacy in real-life contexts is highly needed. Future research can be conducted at different educational levels or with a broader participant scope to explore more deeply the relationship between learning styles and spatial literacy.

## **AUTHOR'S NOTE**

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