Jurnal MIPA dan Pembelajarannya
e-issn: 2798-0634, email: jmipap.journal@um.ac.id

VOL	ISS	YEAR	DOI
6	8	2026	10.17977/um067.v6.i8.2026.4

MATHEMATICAL LITERACY OF UNIVERSITY STUDENTS IN SOLVING HIGHER-ORDER THINKING SKILLS (HOTS) PROBLEMS IN ADVANCED GEOMETRIC TRANSFORMATIONS

Lailatul Adinda Fitria, Nur Lail Feny Andiny, Refni Adesia Pradiarti*

Universitas Sunan Gresik, Jl. Dusun Sidorukun, Kec. Sidayu, Kab. Gresik, Jawa Timur, Indonesia
*Corresponding author, email: ra.pradiarti@lecturer.ac.id

Keywords
Mathematical Literacy
Mathematics Problems
Higher-Order Thinking Skills (HOTS)
Geometric Transformations

Abstract
This study aimed to analyze the mathematical literacy of university students in solving Higher-Order Thinking Skills (HOTS)-based problems on geometric transformations in an Advanced Mathematics course. A descriptive qualitative approach was employed, involving six participants selected through purposive sampling to represent high-, medium-, and low-ability groups. Data were collected using a written HOTS-based mathematics test and analyzed following the data analysis model of Miles, Huberman, and Saldaña. The findings indicate that students' mathematical literacy can be classified into three categories: (1) accurate and appropriate visual representations, (2) inaccurate visual representations, and (3) absence of visual representations. Students in the high-ability category successfully demonstrated all indicators of mathematical literacy, including problem comprehension, solution strategy development, mathematical representation, visualization, and logical reasoning. Students in the medium-ability category exhibited partial understanding but still experienced conceptual misunderstandings and weaknesses in visualization. In contrast, students in the low-ability category were unable to integrate symbolic and visual representations effectively and demonstrated deficiencies across nearly all mathematical literacy indicators. These findings suggest that visual representation is a key factor in successfully solving HOTS-based geometric transformation problems. Therefore, mathematics instruction should be designed using contextual, visual, and HOTS-oriented learning approaches to enhance university students' mathematical literacy.

1. Introduction

The development of 21st-century education requires university students to possess critical thinking, creativity, collaboration, and communication skills to address increasingly complex problems. These competencies are closely associated with Higher-Order Thinking Skills (HOTS), which have become a central focus of contemporary mathematics education. Previous studies have shown that HOTS enhance students' abilities in mathematical analysis, evaluation, and problem solving across various geometry learning contexts (Diana, Agustinasari, et al., 2025). Learning geometric transformations in advanced mathematics requires a high level of abstraction and spatial visualization, making procedural knowledge alone insufficient for achieving meaningful understanding (Turgut, 2022). Consequently, mathematical literacy has become a crucial component in enabling students to solve HOTS-based problems in geometric transformations effectively (Kustiawati et al., 2023).

Mathematical literacy refers to an individual's ability to formulate, apply, and interpret mathematical concepts in a logical and systematic manner across a variety of situations. This competence extends beyond conceptual knowledge to include the ability to connect mathematical ideas with real-world contexts. International studies have reported that university students' mathematical literacy remains relatively low, particularly in solving non-routine problems that require higher-order reasoning (Musa et al., 2025). Research on geometric transformations has also shown that students frequently encounter difficulties in simultaneously understanding visual, spatial, and symbolic representations (Trisna et al., 2022). These challenges are further exacerbated by instructional practices that continue to emphasize routine exercises, leaving students insufficiently prepared to solve HOTS-based problems requiring in-depth analysis and diverse problem-solving strategies (Hakim et al., 2024).

The topic of geometric transformations in advanced mathematics is inherently abstract, as it involves the concepts of translation, reflection, rotation, and dilation in relation to transformation matrix representations. Students are expected to understand the relationships among multiple mathematical representations, including both visual and algebraic forms, to solve problems accurately. Previous studies have demonstrated that spatial ability is significantly associated with students' success in understanding geometric transformations and solving HOTS-based problems (Medoh et al., 2026; Yuliardi & Rosjanuardi, 2021). Furthermore, the use of technology-enhanced learning media, such as GeoGebra and augmented reality, has been shown to improve students' visualization skills and conceptual understanding of geometric transformations (Abdul Hanid et al., 2022). Technology-assisted instruction provides exploratory learning experiences that enable students to understand transformation concepts in a more concrete and interactive manner, thereby fostering the development of their mathematical literacy (Nadarajan et al., 2022).

Successfully solving HOTS-based problems in geometric transformations requires not only a solid understanding of mathematical concepts but also strong mathematical communication and representation skills. Students must be able to interpret information, formulate appropriate solution strategies, and evaluate their results in a logical and systematic manner. Previous studies have shown that students with strong mathematical communication skills tend to have a better understanding of geometric concepts and are more successful in solving higher-order reasoning problems (Rismawati et al., 2025). Conversely, limited mathematical literacy hinders students' ability to connect geometric transformation concepts with real-world contextual problems (Rahayu et al., 2022). These findings suggest that the development of students' mathematical literacy should be supported through innovative instructional strategies that emphasize HOTS and contextual problem-solving (Diana, Agustinasari, et al., 2025).

Based on the foregoing discussion, investigating students' mathematical literacy in solving Higher-Order Thinking Skills (HOTS)-oriented mathematical problems on advanced geometry transformation topics is important. This study is expected to provide an overview of students' abilities to understand, analyze, and solve geometry transformation problems critically and systematically. The findings are expected to serve as a basis for developing innovative instructional strategies that support the improvement of students' mathematical literacy in advanced mathematics courses (Abdul Hanid et al., 2022). Furthermore, strengthening HOTS and mathematical literacy is expected to help students address both academic challenges and the demands of the contemporary digital workplace (Diana, Agustinasari, et al., 2025). Therefore, this study focuses on analyzing students' mathematical literacy in solving HOTS-oriented mathematical problems on advanced geometry transformation topics as an effort to improve the quality of mathematics instruction in higher education (Rahayu et al., 2022).

2. Method

This study employed a descriptive qualitative approach because it focuses on analyzing students' mathematical literacy in solving Higher-Order Thinking Skills (HOTS)-oriented problems on advanced geometry transformation topics. A qualitative approach enables researchers to obtain an in-depth understanding of students' thinking processes, visual interpretation, and mathematical representation skills when solving geometry transformation problems (Feig & Stokes, 2011). A descriptive qualitative design also allows researchers to comprehensively describe students' mathematical literacy without administering any specific treatment to the research participants (Wulandari et al., 2023). Studies on HOTS in geometry transformations indicate that students' abilities should be assessed not only based on their final answers but also on their visualization processes, spatial reasoning, and graphical representations produced during problem-solving.

The research participants consisted of students enrolled in the Primary School Teacher Education program who had completed the advanced mathematics course covering geometry transformations and represented different levels of academic ability. The participants were selected using a purposive sampling technique by considering their academic ability, which was categorized as high, moderate, and low, to obtain more diverse and in-depth data (Wedastuti & Faradiba, 2023).

Qualitative research requires the purposive selection of participants to obtain rich information regarding students' thinking processes and mathematical literacy in solving Higher-Order Thinking Skills (HOTS)-oriented problems. Categorizing students according to their ability levels aimed to provide a comprehensive understanding of variations in mathematical literacy when solving HOTS-oriented problems across different levels of conceptual understanding (Iskandar et al., 2024).

Data were collected through a HOTS-based written test and the collection of students' written responses. The test instrument consisted of HOTS-oriented word problems on geometry transformations that required students to understand the problem context, identify the appropriate type of transformation, and represent the transformation results both visually and mathematically. The HOTS-oriented problems were designed to assess students' mathematical literacy through their ability to interpret problems, construct visual representations, and solve contextual problems involving geometry transformations (Ningsih et al., 2025).

Students' written responses were collected as the primary data source for analyzing their visual representation skills, the accuracy of their transformation drawings, and the conceptual errors that emerged during the process of solving HOTS-oriented problems. The analysis of students' work was conducted to obtain an in-depth understanding of their mathematical literacy in advanced geometry transformation topics. Mathematical visual representation skills are essential to examine, as they provide insights into how students translate the abstract concepts of geometry transformations into accurate graphical representations.

The research instrument was validated through content validity by experts in mathematics education and educational assessment. The validation process was conducted to ensure that the HOTS-oriented problems were aligned with the indicators of mathematical literacy, visual representation skills, and the characteristics of advanced geometry transformation topics. A well-designed instrument for mathematical literacy research should be capable of accurately measuring students' abilities in problem interpretation, mathematical communication, and the use of visual representations. Furthermore, the development of HOTS-oriented instruments should consider the alignment of higher-order thinking indicators with the context of mathematics instruction to ensure that the instrument effectively captures students' reasoning and problem-solving abilities in depth (Pamungkas et al., 2021). The instrument was subsequently revised based on the validators' recommendations to ensure that the test items were capable of comprehensively assessing students' abilities to solve HOTS-oriented geometry transformation problems (Niss & Hojgaard, 2020).

The research data were analyzed using the Miles, Huberman, and Saldaña model, which consists of data reduction, data display, and conclusion drawing. Data reduction was carried out by categorizing students' responses based on their mathematical literacy, conceptual understanding of geometry transformations, and ability to construct graphical representations of transformation results (Miles et al., 2020). The data were presented in the form of narrative descriptions and categorization tables to clearly illustrate the relationship between mathematical literacy and HOTS-oriented problem-solving. The conclusion-drawing stage involved a comprehensive interpretation of the data to obtain an in-depth understanding of students' abilities to understand, represent, and solve HOTS-oriented problems on advanced geometry transformation topics.

This study employed mathematical literacy indicators that include the ability to understand problems, determine appropriate solution strategies, use mathematical representations, construct transformation diagrams, and provide logical justifications for the solution process. Visual representation skills constituted the primary focus of this study because geometry transformations require spatial interpretation and the ability to accurately represent transformed objects. Studies on HOTS in geometry have shown that students frequently encounter difficulties in object visualization, coordinate determination, and the interpretation of transformed figures. Therefore, analyzing visual representations is essential in mathematical literacy research. The analysis of students' transformation diagrams was conducted to determine their level of conceptual understanding in solving HOTS-oriented problems involving geometry transformations (Ningsih et al., 2025).

The research success criteria were determined based on students' ability to construct accurate graphical representations of geometry transformations in HOTS-oriented problems. Students were categorized as "accurate and correct drawings" if they were able to represent the transformations in accordance with the appropriate mathematical concepts and procedures. Students were categorized as "inaccurate drawings" if they produced visual representations that still contained conceptual, positional, or structural errors in the transformation results. Students were categorized as "no drawing" if they did not produce any visual representation or provided only symbolic answers without supporting diagrams of the geometry transformations.

Table 1. Criteria for the Accuracy of Graphical Representations of Geometry Transformation Results

Category	Description
Accurate and Correct Drawing	The student accurately represents the transformation result in accordance with the concepts of translation, reflection, rotation, or dilation.
Inaccurate Drawing	The student produces a graphical representation; however, it contains conceptual errors or the position of the transformed object does not correspond to the transformation concept required in the word problem.
No Drawing	The student does not provide the required visual representation of the geometry transformation.

3. Result and Discusion

3.1. Result

The problem used in this study was a Higher-Order Thinking Skills (HOTS)-oriented task designed to assess students' mathematical literacy in the topic of geometry transformations. The problem presented the context of a graphic designer creating a triangular logo with vertices at A(−1, 5), B(5, 3), and C(3, 2), which subsequently underwent a sequence of transformations consisting of a translation by the vector (−2, 3), a reflection across the y-axis, a 90° counterclockwise rotation about the origin (0, 0), and a dilation centered at the origin (0, 0). Students were required to determine the final coordinates of the vertices and construct a step-by-step sketch illustrating the changes in the triangle's position on the Cartesian plane.

This task assessed several aspects of mathematical literacy, including problem comprehension, strategy formulation, the sequential application of geometry transformation concepts, and visual representation skills. Students were required to integrate symbolic and visual reasoning to solve the problem systematically. Therefore, the task was classified as a HOTS-oriented problem because it involved complex processes of analysis, evaluation, and mathematical representation.

The analysis of students' mathematical literacy in this study was based on the criteria for the accuracy of graphical representations of geometry transformation results, which consisted of three categories: (1) Accurate and Correct Drawing, (2) Inaccurate Drawing, and (3) No Drawing. These criteria were used to evaluate students' ability to visually represent transformation results in accordance with the concepts of translation, reflection, rotation, and dilation. In addition, the analysis was aligned with five mathematical literacy indicators: understanding the problem, determining an appropriate solution strategy, using mathematical representations, constructing transformation diagrams, and providing logical justifications for the solution process. Based on the classification results, two students (S1 and S2) were categorized as Accurate and Correct Drawing, two students (S3 and S4) as Inaccurate Drawing, and two students (S5 and S6) as No Drawing. This distribution indicates that students' mathematical literacy remains uneven, particularly with respect to visual representation skills.

Accurate and Correct Drawing Category

This category corresponds to the criteria presented in Table 1, in which students are able to accurately represent the transformation results in accordance with the relevant mathematical concepts.

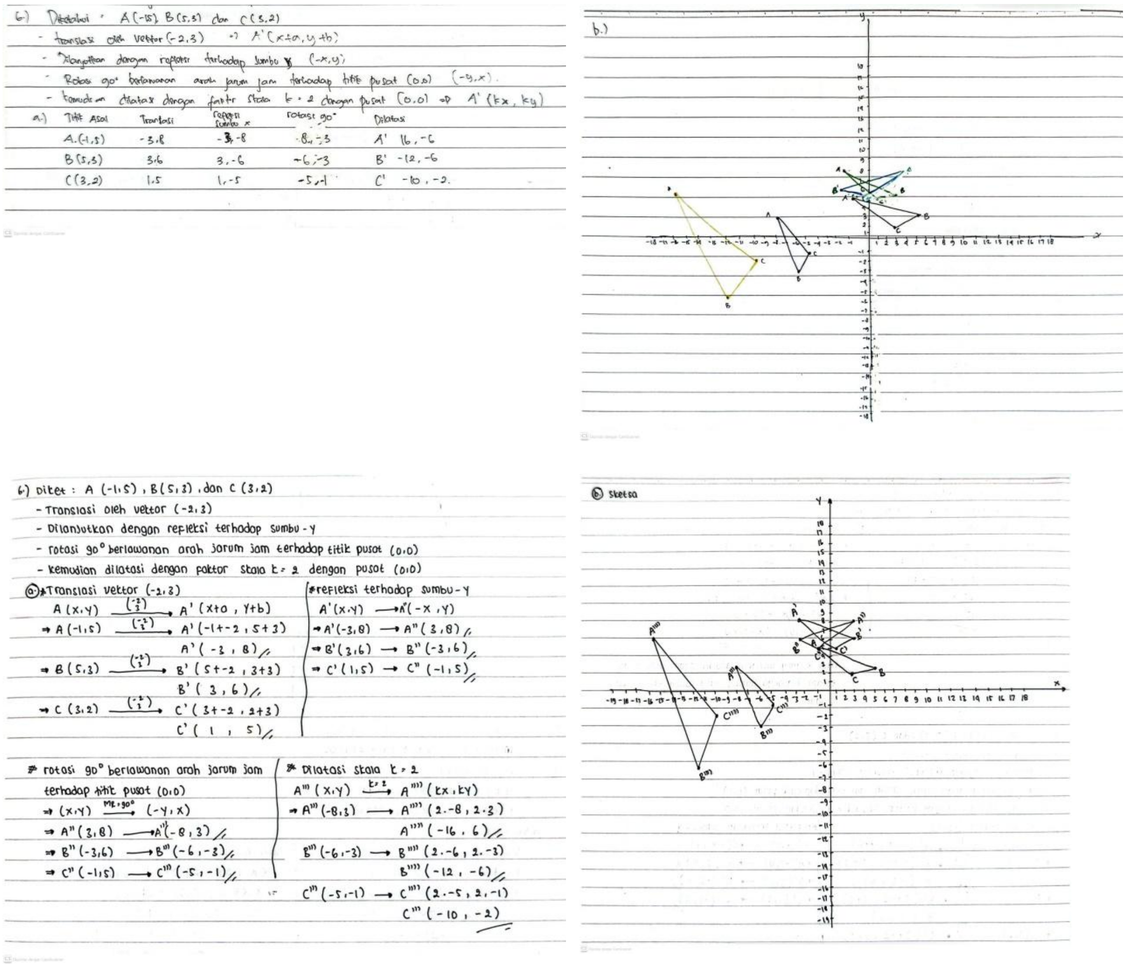

Figure 1. Responses of Participants S1 and S2

Participant S1 demonstrated optimal performance across all mathematical literacy indicators. In terms of problem comprehension, S1 successfully identified all relevant information, including the initial coordinates and the sequence of transformations, without error. Regarding strategy formulation, S1 organized the solution systematically and sequentially in accordance with the underlying mathematical concepts. For mathematical representation, S1 accurately calculated the coordinates resulting from each transformation. In terms of visual representation, S1 produced an accurate graphical representation in which the positions of the vertices, the shape of the figure, and its orientation remained consistent with the principles of geometry transformations. With respect to logical reasoning, S1 clearly explained the relationship between changes in the coordinates and each type of transformation. These findings indicate that S1 possesses a high level of mathematical literacy and is able to effectively integrate symbolic and visual representations.

Participant S2 was also classified in this category because the transformation results were represented accurately. Regarding problem comprehension and strategy formulation, S2 demonstrated a good understanding and correctly followed the required sequence of transformations. In terms of mathematical representation, S2 correctly determined the transformed coordinates, although not all solution steps were presented in detail. For visual representation, the graphical representation accurately reflected the transformation concepts without any distortion of the figure. However, with respect to logical reasoning, S2 provided only limited explanation of the solution process. Nevertheless, S2 satisfied the criteria for the Accurate and Correct Drawing category because the graphical representation was consistent with the required transformation concepts.

Inaccurate Drawing Category

This category corresponds to the criteria presented in Table 1, in which students produce a graphical representation; however, it contains conceptual errors or the position of the transformed figure does not correspond to the transformation required in the problem.

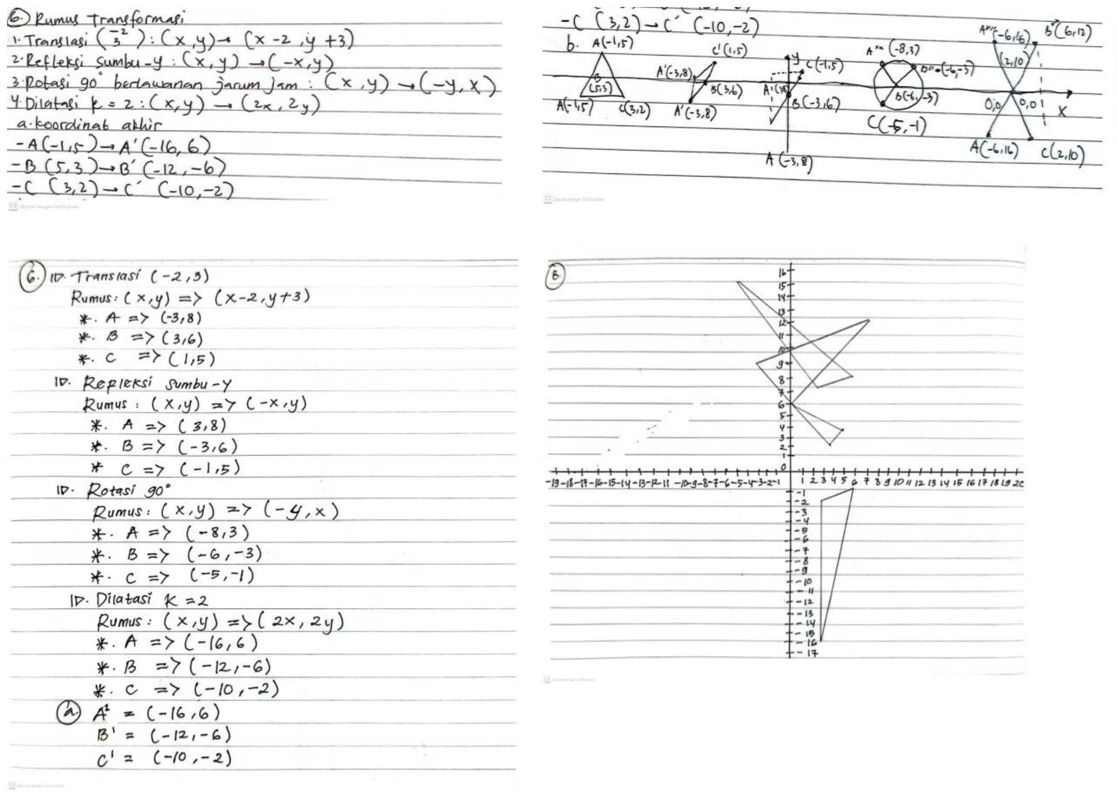

Figure 2. Responses of Participants S3 and S4

Participant S3 demonstrated that several mathematical literacy indicators were achieved; however, the overall performance was not yet optimal. In terms of problem comprehension, S3 was able to identify the basic information but did not accurately understand the required sequence of transformations. Regarding strategy formulation, S3 attempted to solve the problem step by step but did not apply the procedure consistently. In terms of mathematical representation, errors occurred in determining the coordinates resulting from the transformations. For visual representation, S3 produced a graphical representation; however, the positions of the vertices were inconsistent with the transformation concepts, resulting in a distorted figure. With respect to logical reasoning, S3 was unable to clearly explain the relationship between the solution process and the resulting transformations. These findings indicate that S3 had not yet developed a thorough understanding of geometry transformation concepts.

Participant S4 was also classified in this category but exhibited more substantial errors. In terms of problem comprehension, S4 understood the context of the problem but lacked accuracy in identifying the required type of transformation. Regarding strategy formulation, the solution procedure was not systematic. In terms of mathematical representation, errors were found in calculating the transformed coordinates. For visual representation, S4 produced a graphical representation that was inconsistent with the transformation concepts, such as asymmetric reflections or incorrect rotations. With respect to logical reasoning, S4 was unable to provide clear mathematical justification for the solution. These findings suggest that S4 still experienced misconceptions in understanding and applying geometry transformation concepts.

No Drawing Category

This category corresponds to the criteria presented in Table 1, in which students do not provide the required visual representation of the geometry transformation.

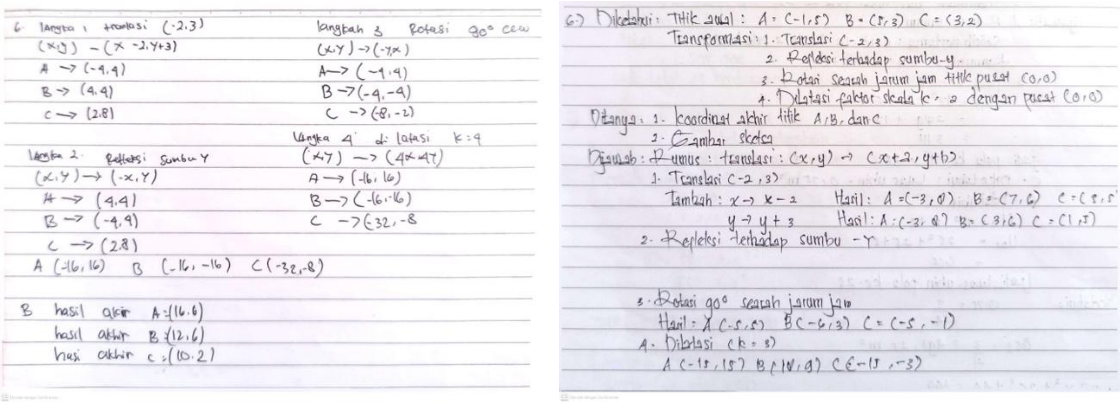

Figure 3. Responses of Participants S5 and S6

Participant S5 demonstrated a low level of mathematical literacy. In terms of problem comprehension, S5 understood only part of the information and did not recognize the importance of visual representation. Regarding strategy formulation, S5 proceeded directly to the calculations without correctly following the required sequence of transformations. In terms of mathematical representation, errors were still evident in determining the transformed coordinates. For visual representation, S5 did not provide any graphical representation, thereby failing to meet the primary assessment criterion. With respect to logical reasoning, S5 was unable to provide a logical explanation of the solution process. These findings indicate that S5 had not yet developed the ability to integrate conceptual understanding with visual representation.

Participant S6 demonstrated an even lower level of performance than S5. In terms of problem comprehension, S6 experienced difficulties in identifying the essential information. Regarding strategy formulation, the solution procedure was unclear. In terms of mathematical representation, fundamental conceptual errors were identified. For visual representation, S6 did not provide any graphical representation. With respect to logical reasoning, no explanation was provided to demonstrate mathematical reasoning. These findings indicate that S6 had not yet achieved the expected mathematical literacy indicators and remained at an initial stage of conceptual understanding.

Overall, when interpreted according to the criteria presented in Table 1, students classified in the Accurate and Correct Drawing category (high level) fulfilled all mathematical literacy indicators. Those in the Inaccurate Drawing category (moderate level) demonstrated achievement of several indicators but still exhibited misconceptions. In contrast, students in the No Drawing category (low level) did not meet the expected mathematical literacy indicators, particularly those related to visual representation and mathematical reasoning. The primary distinction among the three categories lies in the ability to integrate symbolic and visual representations. Participants in the high-level category consistently connected coordinate calculations with accurate visual representations, whereas those in the moderate-level category showed inconsistencies between their calculations and graphical representations. By contrast, participants in the low-level category demonstrated no meaningful relationship between symbolic and visual representations.

3.2. Discussion

The findings indicate that students' mathematical literacy in solving Higher-Order Thinking Skills (HOTS)-oriented problems on geometry transformations varied considerably and could be classified into three main categories: Accurate and Correct Drawing, Inaccurate Drawing, and No Drawing. This variation suggests that students' ability to integrate symbolic and visual representations remains uneven. Students in the high-level category consistently connected coordinate calculations with accurate visual representations, whereas those in the moderate- and low-level categories continued to experience difficulties in relating these two forms of representation (Safitri et al., 2024). These findings indicate that mathematical literacy depends not only on conceptual understanding but also on the ability to represent mathematical concepts visually within a spatial context. This result is consistent with the study by Pradiarti et al. (2024), which reported that students' mathematical literacy remains relatively low, particularly when solving non-routine problems that require higher-order reasoning.

Students in the Accurate and Correct Drawing category (S1 and S2) demonstrated a high level of mathematical literacy because they fulfilled all the assessed indicators, ranging from problem comprehension to the accurate representation of geometry transformation results. These students demonstrated Higher-Order Thinking Skills (HOTS), particularly in the domains of analysis and evaluation during problem-solving. They were not only able to calculate the transformation results procedurally but also capable of accurately visualizing the changes in the figure's position on the Cartesian plane. These findings are consistent with the study by Diana et al. (2025), which reported that HOTS-oriented tasks enhance higher-order thinking through complex problem-solving processes. Furthermore, students' strong visualization abilities are supported by the findings of Aditya et al. (2025), who emphasized the important role of spatial ability in understanding geometry transformation concepts.

Students in the Inaccurate Drawing category (S3 and S4) attempted to represent the transformation results visually; however, conceptual errors and inaccuracies in visualization were still evident. Errors such as reflections performed across incorrect axes or inaccurate rotations indicate that these students had not yet fully understood the relationship between transformation concepts and their visual representations. This finding suggests a gap between symbolic understanding and visual representation skills. These results are supported by the study of Pradiarti et al. (2024), which reported that students often experience difficulties integrating visual, symbolic, and spatial representations simultaneously. This condition also indicates that these students remain in a transitional stage of developing HOTS-based mathematical literacy.

Furthermore, the errors observed in this category suggest that students were not yet accustomed to solving non-routine problems requiring flexible problem-solving strategies. They tended to rely on procedural approaches without developing a deep conceptual understanding. This finding is consistent with Wulandari et al. (2023), who reported that instruction emphasizing routine exercises often leaves students unprepared to solve HOTS-oriented problems that require analysis and evaluation. Therefore, the errors made by S3 and S4 were attributable not only to insufficient conceptual understanding but also to limited experience in solving HOTS-oriented problems.

Students in the No Drawing category (S5 and S6) did not demonstrate any visual representation skills, even though the task explicitly required graphical visualization. This finding indicates that these students were unable to connect geometry transformation concepts with their visual representations on the Cartesian plane. Such performance reflects a low level of mathematical literacy, particularly regarding representation and mathematical reasoning. This result is consistent with the study by Kustiawati et al. (2023), which found that limited mathematical literacy hinders students' ability to relate mathematical concepts to contextual situations and visual representations.

The differences observed among the three categories indicate that visual representation skills constitute a key factor in successfully solving HOTS-oriented geometry transformation problems. Students with high mathematical literacy consistently integrated coordinate calculations with accurate visual representations, whereas those with lower levels of mathematical literacy were unable to establish this connection. These findings are supported by Tyastuti et al. (2025), who reported a significant relationship between spatial ability and success in understanding geometry transformations. This evidence highlights the importance of strengthening visualization skills in advanced mathematics instruction.

In addition, the findings emphasize the importance of implementing innovative technology-based instructional strategies to improve students' mathematical literacy. The use of educational technologies such as GeoGebra and augmented reality can help students develop a more concrete understanding of geometry transformation concepts through interactive visualization. This finding is consistent with the study by Fatmawati and Yahfizham (2024), which concluded that technology integration enhances both visualization skills and conceptual understanding in geometry learning. Therefore, incorporating technology into mathematics instruction represents a promising approach to addressing students' difficulties in understanding geometry transformations.

Overall, the findings reinforce the view that mathematical literacy within the context of Higher-Order Thinking Skills (HOTS) depends not only on procedural competence but also on visual representation skills and mathematical reasoning. These findings are consistent with previous studies demonstrating that instruction integrating symbolic and visual representations enhances students' higher-order thinking abilities. Therefore, mathematics instruction on geometry transformations should be designed to be more contextual, visually oriented, and HOTS-based, enabling students to develop mathematical literacy optimally in meeting the demands of twenty-first-century learning.

4. Conclusion

Based on the findings of this study, it can be concluded that students' mathematical literacy in solving Higher-Order Thinking Skills (HOTS)-oriented problems on geometry transformations exhibits considerable variation. The students were classified into three categories: Accurate and Correct Drawing, Inaccurate Drawing, and No Drawing. Students in the high-level category fulfilled all mathematical literacy indicators, including problem comprehension, strategy formulation, the use of mathematical representations, the accurate construction of transformation diagrams, and the provision of logical justifications for their solutions. In contrast, students in the moderate-level category continued to experience difficulties in applying transformation concepts and producing accurate visual representations, whereas those in the low-level category were unable to represent the transformations visually and demonstrated weaknesses across nearly all mathematical literacy indicators. These findings indicate that the ability to integrate symbolic and visual representations is a key factor in successfully solving HOTS-oriented problems involving geometry transformations.

From a qualitative perspective, the findings also revealed differences in students' patterns of thinking during problem-solving. Students with high mathematical literacy tended to adopt systematic and well-structured approaches while effectively connecting relevant mathematical concepts. In contrast, students with lower mathematical literacy tended to rely on procedural approaches without adequately considering the visual representation aspects of the problem. Therefore, the objective of this study—to analyze students' mathematical literacy—was achieved through the identification and characterization of students' abilities across the three categories. The findings imply that advanced mathematics instruction should be designed to be more contextual, HOTS-oriented, and focused on integrating symbolic and visual representations in order to enhance students' reasoning and problem-solving abilities. However, this study was limited by the relatively small number of participants and its focus on a single instructional topic. Therefore, further research involving a larger sample and a broader range of mathematical topics is recommended to strengthen the generalizability of these findings.

Acknowledgments

The authors would like to express their sincere gratitude to Program Studi Pendidikan Guru Sekolah Dasar, Universitas Sunan Gresik, for providing the academic support and facilities that made this research possible. This support contributed significantly to the successful completion of the research and the preparation of this manuscript.

References

Abdul Hanid, M. F., Mohamad Said, M. N. H., Yahaya, N., & Abdullah, Z. (2022). Effects of augmented reality application integration with computational thinking in geometry topics. Education and Information Technologies, 27(7), 9485–9521. https://doi.org/10.1007/s10639-022-10994-w

Aditya, L., Musa, D., Munir, N. P., Garcia, J. G., & Rodriguez-nieto, C. A. (2025). Students ' problem -solving skills in HOTS geometry tasks : A case study of spatial ability. Jurnal Pendidikan Ma, 16(02), 597–614. https://doi.org/10.24042/ajpm.v16i2.28482

Diana, N., Agustinasari, A., Khatimah, H., Ibnusaputra, M., Adiansha, A. A., & Muslim, M. (2025). HOTS Geometry Analysis on Critical Thinking and Numeracy Skills Reviewed Learning Style and Gender. Edumatica : Jurnal Pendidikan Matematika, 15(2), 245–264. https://doi.org/10.22437/edumatica.v15i2.44262

Diana, N., Khatimah, H., Ibnusaputra, M., & Adiansha, A. A. (2025). HOTS Geometry Analysis on Critical Thinking and Numeracy Skills Reviewed Learning Style and Gender HOTS Geometry Analysis on Critical Thinking and Numeracy Skills …. Jurnal Pendidikan Matematika, 15(2), 245–264. https://doi.org/https://doi.org/10.22437/edumatica.v15i2.44262

Fatmawati, R., & Yahfizham. (2024). Systematic Literature Review : Pemanfaatan Aplikasi Geogebra Pada Materi Transformasi Geometri. International Journal of Mathematics and Science Education, 1(2), 1–11. https://doi.org/https://doi.org/10.62951/ijmse.v1i2.17

Feig, A. D., & Stokes, A. (2011). Qualitative Inquiry in Geoscience Education Research. Qualitative Inquiry in Geoscience Education Research, 7(1), 112–128. https://doi.org/10.1130/spe474

Hakim, L. El, Cahyani, A., & Sovia, A. (2024). Needs Analysis of Learning Devices With Reciprocal Teaching Model Assisted by GeoGebra on Geometric Transformation Material. Pendas : Jurnal Ilmiah Pendidikan Dasar, 09(September), 622–626. https://doi.org/https://doi.org/10.23969/jp.v9i3.18950

Iskandar, I., Wahyudin, W., Suhendra, S., Ramlah, R., & Ardiyanti, Y. (2024). Mathematical literacy of senior high school students on different multiple intelligences groups. Research and Development in Education (RaDEn), 4(2), 1216–1229. https://doi.org/10.22219/raden.v4i2.36300

Kustiawati, D., Azzahra, Z., & Satriawati, G. (2023). Analisis Kemampuan Literasi Spasial Siswa Pada Materi Transformasi Geometri. ALGORITMA: Journal of Mathematics Education, 5(2), 137–152. https://doi.org/10.15408/ajme.v5i2.36435

Medoh, N., Pratiwi, N., & Pradiarti, R. A. (2026). Analisis Pemanfaatan Motif Tenun Ikat Flores sebagai Sumber Belajar Kontekstual melalui Simetri dan Transformasi Geometri dalam Perspektif Etnomatematika. Jurnal Alokantara, 1(1), 31–40.

Miles, M.B., Huberman, a. m., & Saldana, J. (2015). Qualitative Data A Methods Sourcebook. In Etika Jurnalisme Pada Koran Kuning : Sebuah Studi Mengenai Koran Lampu Hijau (Vol. 16, Number 2). Sage Publications.

Musa, L. A. D., Munir, N. P., Muhammad Ikram, Javier Garcia Garcia, & Camilo Andres Rodriguez-Nieto. (2025). Students' problem-solving skills in HOTS geometry tasks: A case study of spatial ability. Al-Jabar : Jurnal Pendidikan Matematika, 16(2), 597–614. https://doi.org/10.24042/ajpm.v16i2.28482

Nadarajan, K., Abdullah, A. H., Syuhada, N., Alhassora, A., Ibrahim, H., Surif, J., Ali, D. F., Zaid, N. M., & Hamzah, H. (2022). The Effectiveness of a Technology-Based Isometrical Transformation Flipped Classroom Learning Strategy in Improving Students ' Higher Order Thinking Skills. IEEE Access, 01, 1–9. https://doi.org/10.1109/ACCESS.2022.3230860

Ningsih, Y. L., Destiniar, Fitriasari, P., & Octaria, D. (2025). Analisis Kebutuhan Instrumen Tes Higher Order Thinking Skills (HOTS) pada Materi Geometri. Indiktika : Jurnal Inovasi Pendidikan Matematika, 7(2), 325–335. https://doi.org/10.31851/indiktika.v7i2.18470

Niss, M., & Højgaard, T. (2019). Mathematical competencies revisited. Educational Studies in Mathematics, 102(1), 9–28. https://doi.org/10.1007/s10649-019-09903-9

Pamungkas, M. D., Zaenuri, & Wardono. (2021). Ethnomathematics: Geometric analysis of historical buildings ngawen temple in Magelang. Journal of Physics: Conference Series, 1918(4), 042102. https://doi.org/10.1088/1742-6596/1918/4/042102

Pradiarti, R. A., Sudirman, & Sisworo. (2024a). Kemampuan Berpikir Kreatif Siswa dalam Menyelesaikan Masalah Open Ended Materi Geometri. Jurnal Teorema: Teori Dan Riset Matematika, 09(November 2023), 93–106. https://doi.org/http://dx.doi.org/10.25157/teorema.v9i1.12782

Pradiarti, R. A., Sudirman, & Sisworo. (2024b). Student's Creative Thinking Process in Solving Multiple Solution Tasks on Geometry Material. Jurnal Pendidikan MIPA, 25(August), 248–263. https://doi.org/http://dx.doi.org/10.23960/jpmipa/v25i1.pp248-263

Rahayu, D. S., Gunawan, Y. A. U., Fitriana, D. A., Sari, Y. A., & Ariska, W. S. (2022). Pengembangan Prototipe E-Modul Matematika Berorientasi HOTS pada Materi Transformasi Geometri Kelas IX. MATHEMA: JURNAL PENDIDIKAN MATEMATIKA, 4(1), 39. https://doi.org/10.33365/jm.v4i1.1805

Rismawati, M., Andri, A., B Rindiani, A., & Wahyudi. (2025). ANALISIS KONEKSI MATEMATIS DAN BERPIKIR KRITIS SISWA KOGNITIF TINGGI PADA MASALAH MATEMATIKA HOTS. Kadikma, 16(2), 27–37. https://doi.org/10.19184/kdma.v16i2.53713

Safitri, F., Nuri, B., & Novianti. (2024). PENGEMBANGAN SOAL HOTS BERBASIS LITERASI MATEMATIKA PADA MATERI TRANSFORMASI GEOMETRI. Jurnal Pendidikan Matematika Dan Sains, 05(02), 130–236.

Trisna, T. A., Ikhsan, M., & Elizar, E. (2022). Abilities and Difficulties of Eight Grade Students in Solving Geometry Transformation Problems. Jurnal Pendidikan MIPA, 23(4), 1724–1737. https://doi.org/10.23960/jpmipa/v23i2.pp1724-1737

Turgut, M. (2022). Reinventing Geometric Linear Transformations in a Dynamic Geometry Environment: Multimodal Analysis of Student Reasoning. International Journal of Science and Mathematics Education, 20(6), 1203–1223. https://doi.org/10.1007/s10763-021-10185-y

Tyastuti, I. F., Pradiarti, R. A., Sabar, & Erdiana, M. (2025). Pengaruh Penggunaan Media Tiga Dimensi Jaring-Jaring Kubus Terhadap Kemampuan Visualisasi Spasial Peserta Didik Kelas Vi Pada Materi Geometri Di Sdn Payaman. Didaktik : Jurnal Ilmiah PGSD STKIP Subang, 11(04), 337–349.

Wedastuti, N. K., & Faradiba, S. S. (2023). Analysis of student's mathematical thinking in solving HOTs problems viewed from mathematics anxiety. International Journal of Trends in Mathematics Education Research, 6(1), 33–40. https://doi.org/10.33122/ijtmer.v6i1.173

Wulandari, S., Kartika Sari, C., Nurcahyo, A., Setyaningsih, R., Surakarta, U. M., & Yani, J. A. (2023). Literasi Matematika Siswa Dalam Memecahkan Masalah Hots. Jurnal Pembelajaran Matematika Inovatif , 6(3), 1033–1043. https://doi.org/https://doi.org/10.22460/jpmi.v6i3.17581

Yuliardi, R., & Rosjanuardi, R. (2021). Hypothetical learning trajectory in student's spatial abilities to learn geometric transformation. JRAMathEdu (Journal of Research and Advances in Mathematics Education), 6(3), 174–190. https://doi.org/10.23917/jramathedu.v6i3.13338