Proceedings of International Conference on Islamic Education (ICIED)
Building an Inclusive and Sustainable Educational System
Volume 11, 2026 (p-ISSN 2477-3638 / e-ISSN 2613-9804)

From reading digital maps to thinking geographically: Assessing students' ability in regional geography in the age of Artificial Intelligence (AI) transformation

Ulfi Andrian Sari[1], Abida Ardelia[2], Izzati Binta Wardati[3]

Correspondence:
ulfiandriansari@uin-malang.ac.id

Affiliation:
Department of Social Education, Faculty of Tarbiyah and Teacher Training, Universitas Islam Negeri Maulana Malik Ibrahim Malang, Indonesia[1]
ulfiandriansari@uin-malang.ac.id

Department of Social Education, Faculty of Tarbiyah and Teacher Training, Universitas Islam Negeri Maulana Malik Ibrahim Malang, Indonesia[2]
230102110055@student.uin-malang.ac.id

Department of Social Education, Faculty of Tarbiyah and Teacher Training, Universitas Islam Negeri Maulana Malik Ibrahim Malang, Indonesia[3]
230102110012@student.uin-malang.ac.id

Abstract
Regional geography education aims to foster geographical thinking, enabling students to comprehend the relationships among physical, social, and spatial phenomena through digital map interpretation in the era of AI transformation. However, regional geography is often perceived as challenging due to its broad scope and the cognitive demands involved in integrating spatial and historical information. While prior research has primarily emphasized the acquisition of factual knowledge, limited attention has been paid to assessing geographical thinking through essay-based map interpretation. This study evaluates students' geographical thinking in a Regional Geography course by adapting Peter Jackson's Geographical Thinking Framework to the context of regional geography studies. A quantitative descriptive design was employed, involving 56 undergraduate students who had completed the Regional Geography course. Data were collected using an essay test designed to assess four dimensions of geographical thinking. The findings reveal an overall mean score of 82.5, indicating a generally good level of geographical understanding. Regarding the specific dimensions of geographical thinking, "Proximity and Distance" achieved the highest score (96.4%), followed by "Space and Place" (94.5%), "Scale and Connection" (85.2%), and "Relational Thinking" (55.1%). The lower result for the "Relational Thinking" dimension indicates that students still struggle to connect various geographical phenomena and explain the interrelationships between components within a region, despite generally demonstrating strong geographical thinking abilities. This study contributes by extending the Geographical Thinking assessment framework to the field of regional geography and provides an evidence-based framework for designing instructional strategies that strengthen spatial-historical reasoning in higher education geography.

Keywords:
Space and place; scale and connection; proximity and distance; relational thinking

A. INTRODUCTION

Digital transformation has revolutionized how students study geography. Digital maps and various geospatial platforms enable students to rapidly access information regarding locations, patterns, distances, and the distribution of phenomena. However, the ability to read digital maps does not necessarily equate to the ability to think geographically (Dix, 2013; Uhlenwinkel, 2013). Research by Karkdijk et al. (2018) indicates that students struggle when required to establish complex, abstract, and interdependent geographical relationships. This suggests that geographical thinking cannot be cultivated solely through map-reading activities or the memorization of regional data. This issue is particularly critical in the study of regional geography, where understanding a region requires more than just a description of its characteristics; it demands the ability to perceive the interrelationships among physical, social, economic, cultural, and environmental factors. In this context, geographical thinking lies at the heart of geography education, enabling students to progress from the mere recognition of facts to reasoning about spatial relationships, processes, patterns, and regional interconnections.

Geographical thinking is often regarded as one of the most significant outcomes of geography education (Brooks et al., 2017). Nevertheless, the definition and conceptualization of geographical thinking have not yet been clearly translated into instructional and assessment practices, as the subject remains a matter of debate (Bendl et al., 2025). Geography education offers a unique perspective for viewing the world, comprehending complex issues, and understanding the interconnections between factors across various scales, from the local to the global. Jackson (2006) outlines four key concepts of geographical thinking: space and place, scale and connection, proximity and distance, and relational thinking. These concepts help students move beyond simple questions of "where?" toward more complex inquiries such as "why there?", "how is it connected to other places?", and "how do these relationships shape a region?".

This issue is also significant within the context of geography education in Indonesia. Various studies indicate that while the use of geospatial technology and map-based learning has expanded, geographical skills remain at a low level (Logayah, 2011). Furthermore, this lack of competence is reflected in students' inability to use maps to describe and analyze geospheric phenomena (Utami et al., 2018). This situation reveals a gap between the availability of geographical technology and students' ability to utilize it to construct geographical explanations. In other words, geography education still faces the challenge of transforming map-reading activities into a process of geographical thinking. This issue is particularly critical in regional geography, as students must comprehend inter-spatial and inter-scale relationships to explain the differences and interconnections between regions.

In Indonesia, research trends regarding geographical thinking are scarce; Indonesian geographers predominantly focus on spatial thinking (Mawarni & Ahyuni, 2025; Sari et al., 2024). Fleming and Mitchell (2017) assert that although parallels exist between the two, spatial thinking is not synonymous with geographical thinking. In an educational context, Mustafé (2019) notes that despite efforts to integrate these concepts, research clearly distinguishes between geographical thinking and spatial thinking. Additionally, Lee (2024) posits that spatial thinking can be understood as a component of geographical thinking, indicating a hierarchical relationship rather than equivalence. This study aims to address the gap in existing research by assessing how digital maps can foster geographical thinking skills within regional geography courses. This work builds upon existing research demonstrating how digital technology can enhance geographical thinking skills (Collins, 2017). Studies by De Miguel González and De Lázaro Torres (2020) note that digital technologies including digital representations such as digital maps and GIS serve as effective tools for enhancing higher-order thinking skills (HOTS).

The importance of geographical thinking skills when reading digital maps is particularly relevant in the era of artificial intelligence (AI). AI and generative AI enable students to rapidly access information, explanations, and even preliminary interpretations regarding a specific region. While these developments offer opportunities to enrich geography education, they also create a risk of student over-reliance on technology-generated answers. Lee et al. (2025)

demonstrate that generative AI has the potential to transform curriculum, pedagogy, assessment, and fieldwork in geography education, while also raising issues such as over-reliance, bias, and information inaccuracy. Lane (2025) also emphasizes the importance of maintaining core geographical thinking skills when AI is utilized in geography education. Consequently, the challenge for geography education in the AI era is no longer merely how students acquire geographical information, but whether they can evaluate, connect, and utilize that information to independently construct geographical reasoning. Although research on spatial thinking, GIS, digital maps, geographical thinking, and AI has expanded, studies specifically linking digital map-reading skills with the four dimensions of geographical thinking within the context of regional geography remain limited, particularly within the Indonesian educational context.

Addressing this gap, this study focuses on students' ability to transition from reading digital maps to thinking geographically during regional geography instruction in the era of AI transformation. Specifically, the study examines students' proficiency in understanding space and place, scale and connection, proximity and distance, and relational thinking when using information from digital maps to explain regional phenomena. The study's novelty lies in its effort to distinguish between students' ability to read geographical information and their ability to use that information to construct geographical thought. Theoretically, this study strengthens the scholarship on geographical thinking by linking geographical concepts with cognitive processes; empirically, it provides evidence regarding the regional geography capabilities of Indonesian students; and pedagogically, it offers a foundation for developing assessments that ask not only "where?" but also "why there?", "how connected?", "at what scale?", and "how do geographical relationships shape a region?". Thus, this study positions digital technology and AI not as a substitute for students' thinking abilities, but as a source of information that must be used critically to strengthen geographical thinking.

B. METHODS

This study employs a quantitative descriptive design. Its objective is to evaluate students' geographical thinking within the Regional Geography course. The sampling technique used is stratified sampling. The research subjects are students who have completed the Regional Geography course. The study was conducted in two 4th-semester classes Class A and Class D within the Social Studies Education study program. These classes were selected based on shared characteristics regarding their interest in the Regional Geography course and nearly identical average scores on previous tests (80 and 80.5, respectively). The study involved 56 respondents, comprising 17 male and 39 female students. The research was carried out from February to July 2026. Class A's instruction took place on Fridays from 06:30 to 08:10, while Class D's sessions were held on Tuesdays from 12:20 to 14:00. Geography instruction in both classes utilized digital map media tailored to the Regional Geography curriculum. Based on a preliminary review indicating both negative and positive impacts of AI, the researcher decided to allow students in the regional geography course across both Class A and Class D to use AI during the 15 scheduled sessions solely for brainstorming purposes, in accordance with the university's AI usage ethics.

The research instrument consisted of five essay questions designed to assess geographical thinking skills. Each question varied in difficulty, with scoring weighted according to the difficulty levels defined in the Revised Bloom's Taxonomy. The maximum possible score for answering all questions correctly was 100. The geographical thinking questions for the Regional Geography course were based on Peter Jackson's (2006) "Geographical Thinking" framework, adapted for the study of regional geography. Table 1 outlines the dimensions of Geographical Thinking and the regional geography learning outcomes, detailing the evaluation components addressed in this study.

Table 1. Dimensions of Geographical Thinking and regional geography learning outcomes

Geographical Thinking Dimension	Revised Bloom's Taxonomy Level	Regional Geography Them	Score
Space and place	C4	Comparing differences in space a on a map	15
scale and connection	C5	Evaluating changes in scale and co regarding size and population on a	25
proximity and distance	C4	Analyzing the influence of proxir distance on different regions on a r	15
relational thinking	C4	Comparing maps showing the l development of a region	15
	C5	Linking social, political, and changes across different regior maps	30

The students had attended 15 class sessions. In the final session—the 16th meeting—they were administered a test to assess their geographical thinking skills. This essay-based test was conducted via Google Forms and completed within a 40-minute timeframe. Students answered the questions without consulting textbooks or utilizing AI assistance.

Data analysis employed a quantitative descriptive approach using a percentage formula. The percentage analysis formula is presented in Figure 1.

$$P = \frac{f}{\sum f} \times 100\%$$

Figure 1. Percentage Formula

Legend:

P : Percentage

f : Indicator achieved

$\sum f$: Total number of indicators

The measurement criteria for the percentage formula are based on the standards outlined in Table 2.

Table 2. Percentage scale criteria

Scale	Indicator
81%-100%	Excellent
61%-80%	Good
41%-60%	Average
21%-40%	Poor
0%-20%	Very Poor

The assessment criteria for passing the Regional Geography course based on geographical thinking ability are determined by the university's mastery standards, as shown in Table 3.

Table 3. Score Conversion for Geographical Thinking Skills

Score	Grade
85-10(	Excellent
70-84	Good
60-69	Satisfactor
50-59	Poor

< 50	Fail

Source: Course grading scale from a State Islamic University

C. RESULT & DISCUSSION

Results should be presented clearly and concisely. This section should summarize the scientific findings rather than providing raw data in excessive detail. Authors are encouraged to highlight the differences between their results and those of previous studies.

The results of the geographical thinking skills assessment for Social Studies Education students in the Regional Geography course are presented in Table 4.

Table 4. Results for the Geographical Thinking dimension (Classes A and D)

Class A	Class D	Average	Average
83.3	81.8	82.5	Good

As shown in Table 4, there was no difference in the average geographical thinking skills between Class A and Class D, despite the classes being held at different times Class A in the morning and Class D in the afternoon. The 1.5 point difference in averages indicates descriptively similar in descriptive terms. Overall, the students' geographical thinking skills fell into the "Good" category.

There was no difference in the average geographical thinking ability between Class A and Class D, despite the classes being held at different times Class A in the morning and Class D in the afternoon. Overall, the students' geographical thinking ability fell into the "good" category.

The data regarding geographical thinking ability are presented in Table 5, detailing the results for each dimension of geographical thinking for both Class A and Class D.

Table 5. Percentage description of Geographical Thinking dimensions

Dimensions of Geographical Thinking	Class A	Class D	Average
Space and place	94 %	95 %	94,5 %
Scale and connection	86 %	84, 4 %	85,2%
Proximity and distance	96,4 %	96,4 %	96,4%
Relational thinking	60 %	50,2 %	55.1 %

Overall, in accordance with Table 5, there were descriptively similar in the geographical thinking dimensions between Class A and Class D, except for the "relational thinking" dimension, where Class A scored higher than Class D. Based on the averages, the dimensions can be ranked from highest to lowest as follows: proximity and distance, space and place, scale and connection, and relational thinking.

Data from Table 5 were visualized using a radar chart to facilitate the comparison of geographical thinking dimensions between Class A and Class D; the differences in averages for each dimension are presented in Figure 2.

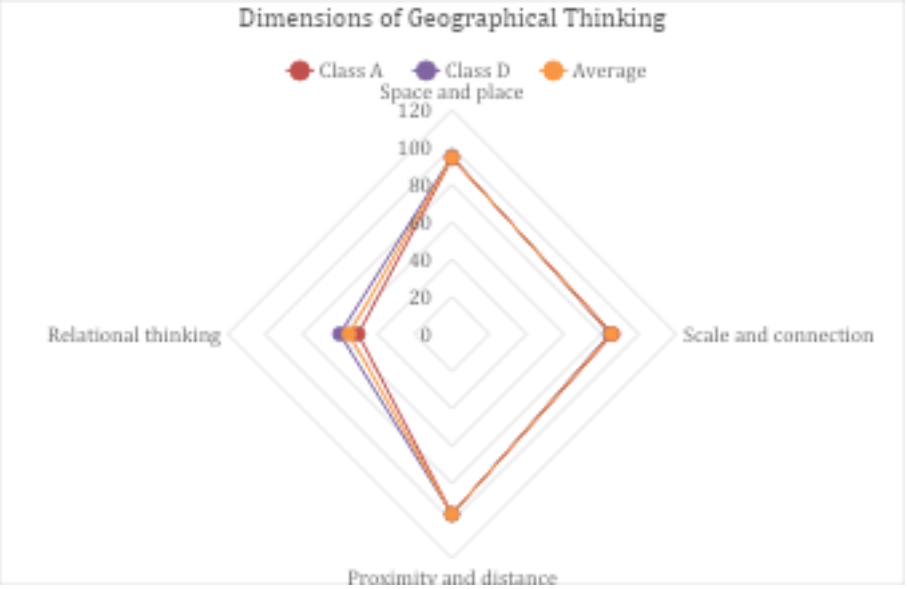


Figure 2: Data visualization of the geographical thinking dimension.

Figure 2 is presented to facilitate the categorization of dimensions within geographical thinking skills. The figure illustrates that the further a value is from zero, the greater the magnitude of that specific geographical thinking dimension. Research findings indicate that while students are capable of "reading space," they are not yet fully proficient in "explaining geographical relationships."

Descriptive analysis reveals that the two classes exhibit relatively similar ability profiles, despite the instruction taking place at different times Class A in the morning and Class D in the afternoon. These findings suggest that the time of instruction was not a significant differentiating factor regarding geographical thinking achievement in this study. This aligns with research by Palacios and Morales (2018), which found no differences in academic achievement or intelligence between adolescents attending these two different school schedules. The similarity may be attributed to the fact that instruction in both Class A and Class D utilized identical methods and media.

The relatively high average scores also indicate that students generally possess a solid foundation for applying geographical concepts to understand regional phenomena. This is consistent with Bendl et al. (2025) , who identify geographical thinking as a crucial outcome of geography education, notwithstanding the complex conceptual and procedural dimensions inherent in the concept. Furthermore, the findings are supported by research Bachmann & Kaiser (2025) showing that interactions with web maps such as spatial navigation contribute positively to geographical thinking skills. On the other hand, the use of digital maps in regional geography instruction can strengthen geographical thinking skills and higher-order thinking. This study also demonstrates that the development of assessment instruments utilized the revised Bloom's taxonomy. The revised cognitive domain taxonomy updated by Anderson et al. in 2001 appears highly suitable for developing increasingly complex learning tasks, serving as a potential tool for fostering geographical thinking (Šimik & Republic, 2024).

When analyzed by dimension, there are more interesting patterns than just the total score. Proximity and distance obtained the highest score (96.4%). This pattern shows that it is relatively easier for students to understand geographical concepts related to position, distance, proximity and characteristics of places compared to the ability to build complex geographic relationships. According to Golledge et al. (2008) state that concepts such as “distance” and “direction” are identified as first-order derivatives of the basic element “location”. The high proximity and distance scores can be understood because the concepts of distance and proximity are easier to observe and represent on maps. Maps provide relatively concrete information about location and distance so that students can relate phenomena to their spatial

position. Bendl et al. (2025) emphasizes that geographical thinking is not only related to geographical concepts, but also the thought processes used to analyze and explain geographical phenomena. Thus, a high score on proximity and distance can indicate that students have mastered spatial aspects that are more easily observed, but must also master more complex geographic relationships. Although students may be able to identify "closeness and distance" through map reading ability, this does not automatically demonstrate geographic thinking ability (Ribeiro, 2022). This expertise is actually only achieved when someone uses these concepts to explain the reasons behind a phenomenon. Specifically, why does the phenomenon appear in different ways in different regions?

The space and place dimension also shows very high achievement with an average of 94.5%. These results indicate that students are able to understand the relationship between space and place in the context of regional geography. This ability is important because regional understanding not only requires knowledge of location, but also the ability to recognize the characteristics of a place. Geographical thinking literature places place and other geographical concepts as one of the important foundations in building a geographical way of thinking. However, high achievements in this dimension still need to be interpreted with caution. A high score can indicate mastery of the concepts of space and place, but to ensure that students are truly thinking geographically, the assessment needs to see whether they are able to use these concepts to explain why the character of a place is formed and how that place relates to other places. In other words, the ability to recognize places needs to develop towards the ability to explain the processes that form places.

The scale and connection dimensions obtained an average of 85.2%. This achievement is considered very good, yet it ranks lower than space and place, as well as proximity and distance. These results indicate that students are starting to be able to understand that geographical phenomena occur at various levels and are interconnected between spaces, but this ability is not as strong as the ability to understand location and distance. This condition is important in learning Regional Geography because the characteristics of a region cannot be understood only through the internal conditions of that region. Regional phenomena are often the result of interactions between local, regional, national and global processes. Research on the use of digital devices in geography learning also shows that integrating geographical thinking into learning activities is not a simple matter. Nilsson and Bladh (2020), for example, found that teachers can understand the importance of geographical thinking, but have difficulty translating it into learning planning and instruction for students. These findings provide an explanation that the ability to understand scales and connections requires more than just the ability to read maps; Students must be trained to zoom in and zoom out and connect phenomena at various scales.

The most significant finding of this study lies in the dimension of relational thinking, which yielded the lowest scores 60% for Class A and only 50.2% for Class D, with an average of 55.1%. The 9.8-point gap between the two classes also represents the only relatively notable difference between them. These results indicate that students struggle to connect various geographical phenomena and explain the interrelationships between components within a region. This finding aligns closely with research by Karkdijk et al. (2018), which demonstrates that relational thinking is a crucial component of geographical thinking and that students face difficulties in establishing complex, abstract, and interdependent geographical connections. Bendl et al. (2025) also highlight that recent studies view relational thinking as an essential part of the geographical thinking process; students are required not only to grasp geographical facts but also to apply conceptual knowledge to establish connections and explain phenomena. Thus, the low relational thinking scores in this study do not merely reflect a weakness in a single indicator but reveal an imbalance in the development of the various dimensions of geographical thinking: while students are relatively proficient at reading and comprehending spatial information, they are less adept at integrating that information into complex geographical explanations.

The low level of relational thinking may also explain why the overall average for

geographical thinking has not reached a very high level, even though the other three dimensions scored in the "good" to "very high" range. In geography education, simply knowing the distance between two regions or recognizing their differing characteristics is insufficient to generate a geographical explanation. Karkdijk et al. (2018) demonstrate that developing relational thinking requires activities that encourage students to establish connections between factors, rather than merely identifying factors in isolation. Consequently, these findings suggest a need to shift away from instruction focused on the identification and description of regional phenomena toward an approach that emphasizes relationships, cause-and-effect, interdependence, and geographical explanation. In a digital context, the use of maps and geospatial technology should not stop at locating places or identifying patterns; instead, it should extend to inquiries that prompt students to explain spatial relationships. Research on digital technology in geography education indicates that technology can support geographical thinking; however, integrating technology with geographical reasoning requires intentional instructional design. The difference in relational thinking between Class A (60%) and Class D (50.2%) also warrants attention. As this study presents only descriptive data, it cannot be concluded that the difference stems from the scheduling of classes (morning versus afternoon). Other factors such as student characteristics, prior learning experiences, types of learning activities, levels of engagement, or task characteristics may contribute to this disparity. Indeed, these findings could serve as a basis for further research to examine the factors influencing the development of relational thinking. This is significant given that a systematic review by Bendl et al. (2025) highlights ongoing challenges in linking conceptual definitions of geographical thinking with methods for empirically developing and evaluating the skill. Thus, this study provides evidence that assessments based on individual dimensions offer greater insight than relying solely on total scores.

D. CONCLUSION

This study indicates that while students possess a solid ability to comprehend spatial information, this level of ability has not yet fully translated into relational geographical thinking skills. The finding regarding limited relational thinking serves as a crucial indicator that success in Regional Geography education cannot be measured solely by a student's ability to identify locations, distances, and regional characteristics; it must also account for their capacity to explain the relationships, interdependencies, and processes that shape a region. Consequently, Regional Geography instruction in the age of digital technology and AI must shift from mere "map reading" to "reasoning with geographical evidence," ensuring that technology acts as a tool to enhance rather than replace students' geographical thinking capabilities.

The research findings highlight the need for instructional interventions that place greater emphasis on relational thinking. Strategies such as problem-based learning, case-based regional analysis, and geospatial data-driven assignments can encourage students to establish connections among physical, social, economic, cultural, and environmental factors. In the context of digital and AI transformation, the use of technology should be directed toward strengthening geographical reasoning rather than supplanting it. Students could be tasked with comparing digital map analyses or AI-generated responses against geographical evidence, subsequently providing justifications grounded in spatial data. This approach is vital because, while Generative AI (GenAI) offers opportunities for personalization, visualization, analysis, and feedback in geography education, it also entails risks such as information inaccuracy, bias, and over-reliance. Therefore, assessment in Regional Geography during the AI era should evaluate not only the final answer but also the reasoning process, the use of geographical evidence, inter-spatial relationships, and the students' ability to construct arguments.

This study is limited by its inclusion of students from only two classes within a single Regional Geography course; thus, the generalizability of the findings to Social Studies Education students or geography education programs in broader contexts requires further investigation. The measurement of geographical thinking in this study focused on four dimensions proposed by Peter Jackson. Although this framework provides a clear structure, geographical thinking

encompasses a broader conceptual scope that may include dimensions such as spatial thinking, integrative thinking, and geographical reasoning. Furthermore, this study did not specifically examine how the use of digital maps and AI influences the development of geographical thinking. Therefore, future research could employ an experimental or mixed-methods design to compare the development of geographical thinking before and after the use of digital technology and GenAI.

REFERENCES

Bachmann, J., & Kaiser, C. (2025). Investigating Web Mapping ' s Contribution to Students ' Learning of Geographical Thinking. *Cartographic Perspectives*, *107*, 28–49. https://doi.org/10.14714/CP107.1781

Bendl, T., Krajňáková, L., Marada, M., & Řezníčková, D. (2025). Environmental Education Geographical thinking in geography education : a systematic review. *International Research in Geographical and Environmental Education*, *34*(4), 326–352. https://doi.org/10.1080/10382046.2024.2354097

Brooks, C., Butt, G., & Fargher, M. (2017). *The Power of Geographical Thinking*. International Perspectives on Geographical Education. https://doi.org/10.1007/978-3-319-49986-4

Collins, L. (2017). The Impact of Paper Versus Digital Map Technology on Students' Spatial Thinking Skill Acquisition. *Journal of Geography*, *117*, 137–152. https://doi.org/10.1080/00221341.2017.1374990

De Miguel González, R., & Lázaro, M. (2020). WebGIS Implementation and Effectiveness in Secondary Education Using the Digital Atlas for Schools. *Journal of Geography*, *119*, 74–85. https://doi.org/10.1080/00221341.2020.1726991

Dix, A. (2013). Mental Geography , Wonky Maps and a Long Way Ahead. *GeoHCI Workshop at CHI*.

Fleming, J., & Mitchell, J. (2017). Effects of Giant Traveling Map Use on Student Spatial Thinking. *The Geographical Bulletin by Gamma Theta Upsilon*, 67–77.

Golledge, R. G., Marsh, M., & Battersby, S. (2008). Matching Geospatial Concepts with Geographic Educational Needs. *Geographical Research*, *46*(1), 85–98. https://doi.org/10.1111/j.1745-5871.2007.00494.x

Jackson, P. (2006). Thinking Geographically. *Geography*, *91*(3), 199–204. https://doi.org/10.1080/00167487.2006.12094167

Karkdijk, J., Schee, J. A. Van Der, & Admiraal, W. F. (2018). Students ' geographical relational thinking when solving mysteries. *International Research in Geographical and Environmental Education*, *2046*, 1–16. https://doi.org/10.1080/10382046.2018.1426304

Lane, R. (2025). Mitigating risks, embracing potential: a framework for integrating generative artificial intelligence in geographical and environmental education. *International Research in Geographical and Environmental Education*, 1–18. https://doi.org/10.1080/10382046.2025.2458561

Lee, J. (2024). *Geographical Thinking Versus Spatial Thinking BT - Handbook of Geography Education* (S. W. Bednarz & J. T. Mitchell (eds.); pp. 109–129). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-72366-7_6

Lee, J., Cimová, T., Foster, E. J., France, D., Krajňáková, L., Moorman, L., Rewhorn, S., & Zhang, J. (2025). Transforming geography education: the role of generative AI in curriculum, pedagogy, assessment, and fieldwork. *International Research in Geographical and Environmental Education*, *34*(3), 237–253. https://doi.org/10.1080/10382046.2025.2459780

Logayah, D. (2011). Relationship Between Teachers Perception of Competence and Professionalism Interest Students With Geographic Skills at High School of Bandung City. *Gea, Jurnal Pendidikan Geografi*, *11*(2), 150–162.

Mawarni, L., & Ahyuni, A. (2025). The Use of Map Media : A Study of Spatial Thinking Skills. *Science Education and Application Journal (SEAJ)*, *7*(1), 72–86.

Nascimento, M. D. (2019). *O ensino de geografia na bncc do ensino fundamental (anos iniciais e*

anos finais): a escala geográfica e o conceito de lugar com vistas à formação cidadã do aluno. Universidate Federal De Goias.

Palacios, A. A., & Morales, J. F. D. (2018). Morningness – eveningness is not associated with academic performance in the afternoon school shift : Preliminary findings. *British Journal of Educational Psychology*, *88*, 480–498. https://doi.org/10.1111/bjep.12196

Ribeiro, P. A. da S. (2022). Spatial Thinking and Geographic Reasoning: Approaches and Distances. *Signos Geográficos, Goiânia*, *4*, 1–13. https://doi.org/www.revistas.ufg.br/signos

Sari, U. A., Rizki, K. F., & Pujianti, B. (2024). Analysis of Spatial Skills Impact of Science , Technology , Engineering , And Mathematics (STEM) Approach in Cartography Learning. *Jurnal Geografi*, *16*(2), 216–226. https://doi.org/https://doi.org/10.24114/jg.v16i2.50181 -

Šimik, O., & Republic, C. (2024). Developing Geographical Thinking in Primary School Pupils through Gradual Learning Tasks. *The International Journal of Science, Mathematics and Technology Learning*, *31*(1), 55–71.

Uhlenwinkel, A. (2013). Spatial Thinking or Thinking Geographically ? On the Importance of Avoiding Maps without Meaning. *GI_Forum 2013. Creating the GISociety*, *2013*, 294–305. https://doi.org/10.1553/giscience2013s294.Spatial

Utami, W. S., Zain, I. M., & Sumarmi, S. (2018). Geography literacy can develop Geography skills for high school students : is it true ? Geography literacy can develop Geography skills for high school students : is it true ? *IOP Conference Series: Materials Science and Engineering*, 1–6. https://doi.org/10.1088/1757-899X/296/1/012032