2nd Renaisans International Conference on SDGs

Entita: Jurnal Pendidikan Ilmu Pengetahuan Sosial dan Ilmu-Ilmu Sosial
Special Edition, May 2026
ISSN: 2715-7555 (Print), ISSN: 2716-1226 (Online)
DOI: 10.19105/ejpis.v2i.24445

The Effect of Geopedia Web-Based Learning on Students' Spatial Thinking Skills in Geography Learning

Saiful Amin[1*], Abdul Bashith[2], Muchammad Akbar Kurniawan[3], Sari Dewi[4], Muhammad Akmal Muzakki Dwi Syah Putra[5], Mahadir Muhammad Fikri Rohmatulloh[6]
[1,2,3,5,6] Universitas Islam Negeri Maulana Malik Ibrahim, Malang, Indonesia
[3] Sekolah Menengah Pertama Brawijaya Smart School, Malang, Indonesia
[4] Universitas Negeri Surabaya, Surabaya, Indonesia
[4] Madrasah Ibtidaiyah Al-Fattah Darussalam, Malang, Indonesia

Article Info

Article History*:*

Received 04 25, 2026
Revised 05 14, 2026
Accepted 05 20, 2026

Keywords*:*

Geopedia Web Based Learning;
Spatial Thinking;
Geography Learning.

Abstract

The limited spatial thinking skills in students can be attributed to traditional geography instruction and the insufficient integration of technology-based learning tools. This research seeks to examine the impact of using Geopedia web media within web-based learning on students' spatial thinking abilities, specifically regarding lithospheric materials, at MA Ahmad Yani Jabung, Malang Regency. This research employs a quantitative method with a quasi-experimental framework, utilizing a one-group pretest-posttest design on a sample of 23 eleventh-grade students. The research tool consists of a multiple-choice test that has undergone validity, reliability, discrimination, and difficulty testing, and was subsequently analyzed using the Paired Sample T-Test. According to the results, there was an increase in the mean spatial thinking ability of students, demonstrating a notable difference before and after the intervention. According to the discussion, Geopedia web media proves to be more effective in improving students' spatial thinking skills. This is because it delivers a learning experience that is more engaging, visually rich, and context-based, enabling students to understand spatial concepts in a more profound and applicable manner than conventional methods.

[Rendahnya kemampuan berpikir spasial siswa disebabkan oleh proses pembelajaran geografi yang masih didominasi metode konvensional serta kurangnya pemanfaatan media pembelajaran berbasis teknologi. Penelitian ini bertujuan untuk menganalisis pengaruh penggunaan media web Geopedia dalam pembelajaran berbasis web terhadap kemampuan berpikir spasial siswa pada materi litosfer di MA Ahmad Yani Jabung, Kabupaten Malang. Penelitian menggunakan pendekatan kuantitatif dengan desain eksperimen kuasi tipe *one group pretest-posttest* yang melibatkan 23 siswa kelas XI sebagai sampel penelitian. Instrumen yang digunakan berupa tes pilihan ganda yang telah melalui uji validitas, reliabilitas, daya pembeda, serta tingkat kesukaran soal. Selanjutnya, data dianalisis menggunakan teknik *Paired Sample T-Test* untuk mengetahui perbedaan kemampuan siswa sebelum dan sesudah perlakuan. Hasil penelitian memperlihatkan bahwa kemampuan berpikir spasial siswa secara rata-rata naik, serta ditemukan perbedaan yang signifikan pada kondisi sebelum dibandingkan dengan sesudah perlakuan. Media web Geopedia lebih unggul dalam meningkatkan kemampuan berpikir spasial siswa dibandingkan pembelajaran konvensional. Keunggulan ini berasal dari pengalaman belajar yang lebih interaktif, visual, dan kontekstual yang disediakan.] © The Authors.

Corresponding Author:

Saiful Amin
Universitas Islam Negeri Maulana Malik Ibrahim Malang
Jalan KH Malik Dalam Gg 1, No 22C, Buring, Kecamatan Kedungkandang, Kota Malang, Indonesia
Email: amin.geo87@pips.uin-malang.ac.id

1. Introduction

Geography as a discipline basically studies geosphere phenomena by emphasizing the relationship between elements systematically and comprehensively. The objective of geographical material focuses on the specific characteristics of a phenomenon that is studied thoroughly [1], [2], [3]. Singh [4] explains that geographic material objects are vast and include the geosphere consisting of the lithosphere, atmosphere, hydrosphere, biosphere, pedosphere, and anthroposphere. Given that the lithosphere is a highly important object of study in this component, it needs to be embedded into the geography teaching and learning process. The material studied in this context is related to the geological and geomorphological processes that play a role in the physical formation of the Earth [5], [6], [7], [8]. The study of geography also concentrates on the processes of the lithosphere and their consequences for human life. Vasconcelos and Orion [9] emphasized that learning activities such as observation, scientific communication, report preparation, problem identification, and the formulation of solutions to the impact of lithospheric dynamics are important parts of achieving basic competencies.

Understanding geography requires adequate spatial thinking skills. A deep mastery of the concept of geography encourages the emergence of innovations in the learning process [10], [11], [12], [13]. In this case, teachers are required to develop creativity so that learning can take place more effectively and efficiently [14], [15]. These efforts are directed at improving students' spatial thinking skills, which have an important role in understanding geographical phenomena contextually [16], [17]. Purwanto et al. [18], Nursa'ban et al. [19], and McLaughlin & Bailey [20] state that improved spatial thinking skills enable students to recognize geographic environments, understand the characteristics of regions, master spatial aspects, and contribute to regional management and planning.

Despite this, various studies demonstrate that students continue to have relatively poor spatial thinking skills. Salam et al. [21] and Adzani et al. [22] reported that the average spatial thinking ability of students was in the low category, namely 53 and 56.4, respectively. According to the findings, these low outcomes stem from conventional geography learning being the primary approach, alongside teachers' minimal utilization of technology. In line with that, Alvia et al. [23] It was found that more than 50% of students have very low spatial thinking skills due to the lack of optimal development of comprehensive spatial analysis tools. This circumstance causes learners to have a limited grasp of just one area, but they encounter challenges in examining other areas owing to the insufficient spatial skills acquired in the classroom setting.

Preliminary observations of grade X Geography learners at MA Ahmad Yani Jabung, Malang Regency, indicated that only 57% of the 60 students were able to reach the average score on the indicator measuring spatial thinking ability. This condition is influenced by *teacher-centered learning*, where the delivery of material is dominated by lecture methods and examples of spatial analysis questions in the absence of students' active engagement. Additional factors that impair the cultivation of students' spatial thinking include a scarcity of learning projects, weak student initiative in handling tasks, and the underuse of educational media.

As an effort to overcome these problems, the use of web-based technology is one of the alternatives that can be applied [24], [25]. It is widely believed that employing technology in education positively influences learning results. Web media has various advantages, including improving learning outcomes [26], [27], increasing interest in learning [28], [29], increasing cognitive comprehension [30], [31], and increasing students' creativity [32]. However, research on the specific effect of web learning on spatial thinking skills is still limited. The purpose of this research is to determine the effect that web learning has on spatial thinking skills. In addition, this study is relevant to the achievement of Sustainable Development Goal (SDG) 4 on Quality Education, particularly in promoting effective, inclusive, and technology-based learning. The integration of web-based learning in geography education can support the development of students’ spatial thinking, digital literacy, and active learning participation as essential competencies in 21st-century education. Therefore, this research contributes not only to geography learning innovation but also to broader efforts to improve the quality of education through digital learning environments.

2. Method

This type of research uses a quantitative approach with a quasi-experimental design to determine the influence of Geopedia web media on students' spatial thinking skills [33]. As illustrated in Table 1, the research utilizes a One Group Pretest Posttest design.

Table 1. Design One Group Pretest-Posttest

Pretest	Treatment	Posttest
O_1	X	O_2

Source: Creswell & Creswell [34]

Description:

O_1 : Pretest is given before treatment
O_2 : Posttest is given after treatment
X : Learning with Geopedia web media through the Problem Based Learning model

This research was conducted at MA Ahmad Yani Jabung, Malang Regency in the 2023/2024 school year. MA Ahmad Yani Jabung was chosen because it is located in the Malang Regency area with a rural environment that has distinctive social and geographical characteristics, is close to hilly or mountainous areas in the eastern Malang region, and has easy access for researchers so as to support the smooth data collection process without significant obstacles. The research sample is class XI which totals 23 students using the purposive sampling method based on cognitive results related to the technological ability that is important.

The instrument for assessing students' spatial thinking ability uses test questions. The form is a multiple-choice question of 12 items based on indicators: spatial interaction, scale, application, representation, analysis, and comprehensive [35]. Before being used for data collection, test questions were tested 1) validity with the product moment correlation technique; 2) reliability with Cronbach's Alpha; 3) the power of differentiating questions; and 4) the difficulty level of the question [36].

The test instruments measuring students' spatial thinking skills were first evaluated through validity, reliability, item discrimination, and difficulty level analyses. The outcomes of the validity and reliability assessments are provided in Table 2.

Table 2. Validity and Reliability Results of Spatial Thinking Questions

No	Validity Test			Reliability Test	
	T count	T table	Decision	Cronbach's Alpha	Decision
1	0.675	0.2960	Valid	0.718	Reliabel
2	0.641	0.2960	Valid		
3	0.478	0.2960	Valid		
4	0.472	0.2960	Valid		
5	0.492	0.2960	Valid		
6	0.422	0.2960	Valid		
7	0.460	0.2960	Valid		
8	0.400	0.2960	Valid		
9	0.566	0.2960	Valid		
10	0.417	0.2960	Valid		
11	0.424	0.2960	Valid		
12	0.467	0.2960	Valid		

Table 2 indicates that all 12 spatial thinking test items obtained calculated T-values exceeding the critical value of 0.2960, which confirms that the items are valid. In addition, the Cronbach's Alpha coefficient of 0.718, which is higher than 0.7, suggests that the instrument has acceptable reliability. Furthermore, the results of the item discrimination and difficulty level analysis are presented in Table 3.

Table 3. Differentiation and Difficulty Test of Spatial Thinking

No	Differentiation Test		Difficulty Level Test	
	Index	Criteria	Indeks	Criteria
1	0.675	Effective	0.53	Medium
2	0.641	Effective	0.60	Medium
3	0.478	Effective	0.57	Medium
4	0.472	Effective	0.60	Medium
5	0.492	Effective	0.67	Medium
6	0.422	Effective	0.83	Easy
7	0.460	Effective	0.47	Medium
8	0.400	Effective	0.60	Medium
9	0.566	Effective	0.63	Medium
10	0.417	Effective	0.70	Medium
11	0.424	Effective	0.60	Medium
12	0.467	Effective	0.67	Medium

According to Table 3, the average item discrimination index is declared effective, which means the questions are categorized as Good Questions. Moreover, the difficulty test findings demonstrate that 11 questions are at a moderate difficulty level, and one question is rated as easy.

Before conducting the main analysis, prerequisite tests including normality and homogeneity were carried out, with a significance threshold of greater than 0.05. The treatment effect was subsequently evaluated using a Paired Sample T-Test, applying a significance level of less than 0.05. All statistical analyses were performed using SPSS version 23.0 for Windows. Hypothesis testing was conducted based on students' spatial thinking ability scores, and the results are presented in the following section.

H0: No difference exists in students' spatial thinking skills prior to and following the use of Geopedia web media during instruction.

H1: A difference exists in students' spatial thinking skills prior to and following the use of Geopedia web media during instruction.

3. Results

The implementation of the use of Geopedia in hybrid learning with the application of the PBL model. The learning steps follow the PBL learning syntax, namely 1) student orientation to the problem; 2) student organizations on problems; 3) observation and investigation; 4) presentation of the results of problem solving; and 5) evaluation of the problem-solving process [37]. The following is the learning in class presented in figure 1 as follows.

Figure 1. Implementation of Learning in the Classroom

Then, a comparison of the experimental and control class learning outcomes data in this study can be seen in Figure 2 below.

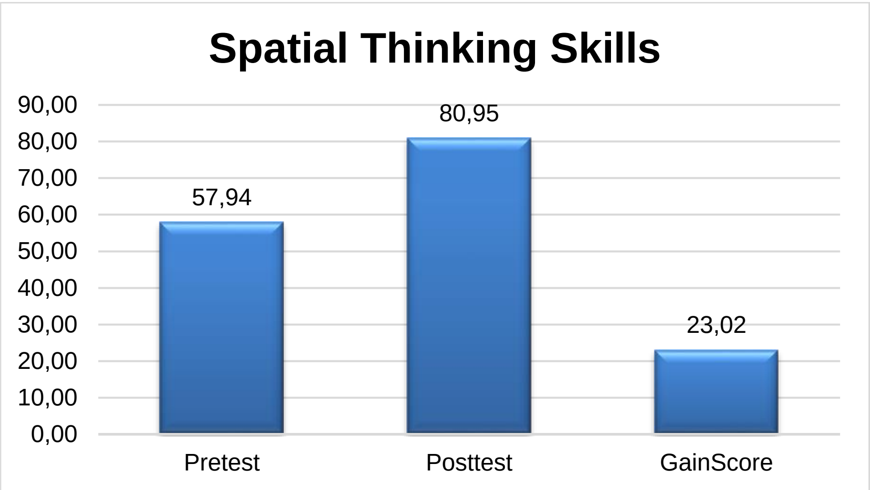

Figure 2. Students' Spatial Thinking Ability Data

The learning outcome data in figure 2 shows that the average result of spatial thinking skills before using Geopedia web media is 57.94. Furthermore, the average result of spatial thinking ability after using web learning was 80.95. Thus, the improvement in spatial thinking skills from before to after the use of web-based learning was 23.02 points. It can be concluded that the web learning media developed has successfully assisted students in enhancing their spatial thinking abilities.

Then, the percentages of various indicators used to measure spatial thinking skills are also presented in Figure 3.

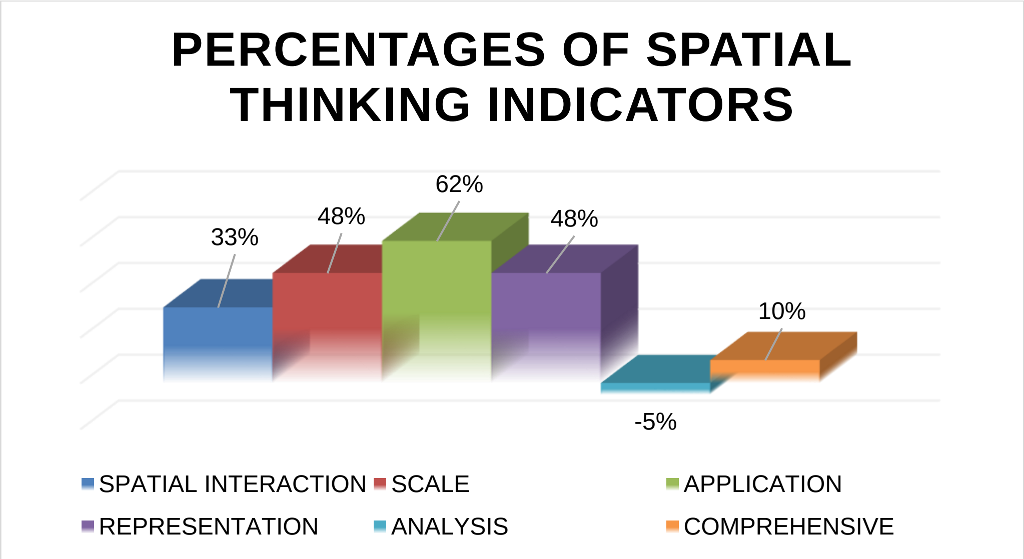

Figure 3. Spatial Thinking Indicator Percentage Data

Based on Figure 3, data from the spatial thinking indicator shows that the application indicator obtained the highest score, which is 62%. This indicates that the participants' ability to apply spatial concepts is at a very good level. In contrast, the indicator that obtained the lowest score was the analysis, with a value of -5%. These values indicate significant difficulties in spatial analysis skills, where participants may experience challenges in decomposing, understanding, and evaluating more complex spatial relationships.

Prior to the effectiveness analysis, normality and homogeneity tests were performed on the learning outcome data. A paired sample t-test was subsequently used to evaluate the effectiveness of the treatment. The outcomes of the normality test are presented in Table 4, while the results of the homogeneity test are shown in Table 5.

Table 4. Normality Test Results

Tests of Normality

		Shapiro-Wilk		
	Results	Statistic	df	Sig.
Spatial Thinking	Pretest	.917	21	.076
	Posttest	.911	21	.057

Table 5. Homogeneity Test Results

Test of Homogeneity of Variance

		Levene Statistic	df1	df2	Sig.
Spatial Thinking	Based on Mean	.041	1	40	.840
	Based on Median	.027	1	40	.869
	Based on Median and with adjusted df	.027	1	36.723	.870
	Based on trimmed mean	.042	1	40	.838

Based on table 4, the results of the normality test using Shapiro Wilk were due to the number of respondents being less than 100 [38]. The results obtained sig 0.076 > 0.050 in the pretest results and sig 0.057 > 0.05 in the posttest results so that it was concluded that the gain score value in spatial thinking skills was normally distributed. Referring to Table 5, the significance value of 0.840 exceeds the threshold of 0.050, suggesting that the gain scores of spatial thinking ability fulfill the requirement for homogeneity of variance. A subsequent analysis of the difference between pretest and posttest spatial thinking outcomes was then performed, the results of which are summarized in Table 6.

Table 6. Paired Sample T-Test Results

		Paired Samples Test							
		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Spatial Thinking	Pretest - Posttest	-80.000	9.555	2.085	-84.349	-75.651	-38.368	20	0.000

Based on the t-test results in Table 6, the obtained significance value is 0.000 (< 0.050), leading to the rejection of H0. Consequently, it can be concluded that there is a significant difference in spatial thinking ability between students who utilized Geopedia web media and those who did not employ web-based learning media. Web media development products are effective in improving spatial thinking skills, Geography, especially lithosphere materials.

4. Discussion

Based on the results of the analysis, the researcher found that the spatial thinking ability of MA Ahmad Yhani Jabung students was influenced by teaching geography through web media. The results showed that web-based learning was better than conventional model learning which consisted only of discussions, lectures, and questions and answers. Therefore, the model uses web learning media better than conventional models to teach students spatial thinking which makes students have overall spatial thinking skills. Web-based learning provides a variety of interactive tools and visualizations that help students understand spatial concepts more clearly and deeply.

Research shows that there is a difference in spatial ability based on conventional learning models and web-based models [39], [40], [41]. These results strengthen the research by Syaviar [42] who stated that some students in Kediri Regency have good spatial thinking skills because they are influenced by learning using cutting-edge learning technology. Furthermore, this study underscores the importance of innovation in teaching methods to improve the quality of learning. The research conducted by Hulu & Dwiningsih [8] and Kutor et al. [9] Revealed, through the adoption of technology and more modern approaches, such as e-learning, teachers can create a more dynamic learning environment and support the development of cognitive skills and spatial thinking. This is not only true for spatial abilities, but it can also impact a variety of other aspects of a student's academic and personal development.

Furthermore, of the indicators of spatial thinking that include spatial interactions, scale, application, representation, analysis, and comprehensiveness, the indicator that shows the highest value is application. [45] [45] revealed that this is because the app's ability reflects participants' skills in applying spatial concepts practically in real-world situations, such as solving spatial problems or applying spatial principles in various contexts. This is supported by Choiri et al. [46] that this ability is often easier to master than other indicators, such as analysis or representation, which demand a more in-depth and abstract understanding of spatial relationships.

The advantages of these application indicators can also be attributed to a more focused approach to learning and concrete tasks, which makes it easier for participants to connect theory with practice [47]. Indicators such as analysis and representation tend to require more critical and abstract thinking skills, which may be challenging for some participants. The difference in achievement between these application indicators and other indicators shows that aspects of spatial thinking require a diverse approach in the teaching process, so that all aspects can be mastered in a balanced manner.

This research is corroborated by Edgar Dale's theory which states that web-based learning can provide virtual experiences that are close to reality through simulations, animations, and interactivity [48]. In the context of this study, the integration of web-based learning facilitated students' active engagement with spatial concepts through simulations, animations, and interactive exploration. Such features allowed students not only to observe geographic phenomena visually but also to interact with learning materials in ways that are difficult to achieve through conventional lecture-based instruction. The increased student participation and improved conceptual understanding observed during the learning process indicate that virtual learning experiences can reduce the abstract nature of spatial concepts and promote deeper cognitive processing. These findings suggest that Dale's theory remains relevant in contemporary digital learning environments, particularly in geography education where visualization and spatial interaction play a crucial role in concept comprehension.

In addition, Brown [14] and Johnson et al. [15] Explains that web-based learning platforms allow for efficient online collaboration, where students can work in teams to complete projects that require spatial thinking. Features such as collaborative workspaces, discussion forums, and document sharing tools allow for real-time interaction and collaboration even when students are in different locations. Aliman et al. [51] He said that good geography learning also engages students in contextual interaction with learning support technology so that students can learn more about the surrounding world.

The research conducted by Yani et al. [52] that there is a decline in spatial thinking skills, geography is less innovative in learning. Another study in Vietnam also stated that because spatial questions and concepts in geography textbooks contain fewer spatial components compared to non-spatial components [53]. In addition, the reality in the field was found that the percentage of grade XII students in Bengkulu was around 43.55% who had sufficient spatial thinking skills, and only about 38.71% had mastery of spatial geography skills in students [54]. This shows how important technological innovation is in learning. Developing and adopting new methods and technologies, such as web-based learning, can create a more effective and engaging educational environment for students [55], [56], [57], [58], [59]. Innovation in learning not only helps students understand the subject matter better, but also prepares them to face real-world challenges with relevant and up-to-date skills

It can be inferred from this that the implementation of a web-based learning media model is claimed to foster the development of students' spatial thinking abilities in the context of Geography subject matter. Learning that tends to make students active has an emphasis on students' thinking ability on well-fulfilled material, which is known from the results of research that shows that classes using web learning media have a greater average score than conventional model classes.

5. Conclusion

The findings of this study indicate that the use of Geopedia web media within a web-based learning approach based on the Problem Based Learning (PBL) model effectively enhances students' spatial thinking abilities. This conclusion is supported by the noticeable improvement in students' scores from pretest to posttest, as well as the results of the paired sample t-test, which reveal a statistically significant difference between measurements before and after the treatment. Indicator level analysis revealed that the application dimension achieved the highest scores, whereas the analysis dimension remained a relative weakness requiring further instructional attention. Consequently, while the integration of web-based learning media comprehensively enhances spatial thinking abilities, additional emphasis on higher order thinking skills is necessary to attain more optimal learning outcomes.

The main limitation of this study is related to the research design, which involved only one class without the inclusion of a broader comparison group. As a result, the findings of this study cannot be generalized more widely. Another limitation is that the study was implemented in only one school in Malang Regency, thus the contextual applicability of the findings is restricted to the particular attributes of that site. In addition, the learning materials used only focus on the lithosphere, so they have not yet described the effectiveness of Geopedia web media on other more diverse geography materials. Another constraint of this study is the relatively limited research period, preventing a comprehensive assessment of the long-term impact of media utilization. Therefore, further research is recommended to expand the scope of the sample to several schools, develop the use of various geographical materials, improve the interactive features and visual design of Geopedia web media, and extend the duration of the study so that the results obtained are stronger, consistent, and can be generalized more widely.

Acknowledgments

The researcher would like to express sincere appreciation to the Faculty of Tarbiyah and Teacher Training at the State Islamic University Maulana Malik Ibrahim Malang in 2024. The researcher also extends gratitude to MA Ahmad Yani Jabung for granting permission, as well as for the support and assistance provided throughout the research process, which contributed to the smooth implementation of the study.

AI Acknowledgment
The authors state that no generative AI or AI-assisted tools were utilized in the preparation, writing, or completion of this manuscript. The authors further affirm that they are the sole contributors to this article and assume full responsibility for its content, in accordance with COPE guidelines.

Funding Information
This research received financial support from the Faculty of Tarbiyah and Teacher Training, Maulana Malik Ibrahim State Islamic University, Malang, in 2024 through the Student and Lecturer Recognition Research Program.

References

[1] T. Cresswell, *Geographic Thought: A Critical Introduction*. John Wiley & Sons, 2024.
[2] R. Meylani, "A Comparative Analysis of Traditional and Modern Approaches to Assessment and Evaluation in Education," *WAJES*, vol. 15, no. 1, pp. 520–555, Apr. 2024, doi: 10.51460/baebd.1386737.
[3] P. Kedron, A. E. Frazier, A. B. Trgovac, T. Nelson, and A. S. Fotheringham, "Reproducibility and Replicability in Geographical Analysis," *Geographical Analysis*, vol. 53, no. 1, pp. 135–147, 2021, doi: 10.1111/gean.12221.
[4] V. Singh, "The Environment and Its Components," in *Textbook of Environment and Ecology*, V. Singh, Ed., Singapore: Springer Nature, 2024, pp. 1–13. doi: 10.1007/978-981-99-8846-4_1.
[5] B. Abebe, D. Ayalew, A. Regassa, and G. Taye, "Geology and Geomorphology," in *The Soils of Ethiopia*, S. Beyene, A. Regassa, B. B. Mishra, and M. Haile, Eds., Cham: Springer International Publishing, 2023, pp. 51–69. doi: 10.1007/978-3-031-17012-6_4.
[6] L. B. Leopold, M. G. Wolman, J. P. Miller, and E. E. Wohl, *Fluvial Processes in Geomorphology*. Courier Dover Publications, 2020.
[7] K. J. Tinkler, *A Short History of Geomorphology*. Routledge, 2020.
[8] E. Keller *et al.*, "Applications in geomorphology," *Geomorphology*, vol. 366, p. 106729, Oct. 2020, doi: 10.1016/j.geomorph.2019.04.001.
[9] C. Vasconcelos and N. Orion, "Earth Science Education as a Key Component of Education for Sustainability," *Sustainability*, vol. 13, no. 3, p. 1316, Jan. 2021, doi: 10.3390/su13031316.
[10] K. J. Gregory and J. Lewin, "Big Ideas in the Geography Curriculum: Nature, Awareness and Need," *Journal of Geography in Higher Education*, vol. 47, no. 1, pp. 9–28, Jan. 2023, doi: 10.1080/03098265.2021.1980867.
[11] R. B. Schultz and M. N. DeMers, "Transitioning from Emergency Remote Learning to Deep Online Learning Experiences in Geography Education," *Journal of Geography*, vol. 119, no. 5, pp. 142–146, Sep. 2020, doi: 10.1080/00221341.2020.1813791.
[12] B. Wijayanto, Sumarmi, D. H. Utomo, B. Handoyo, and M. Aliman, "Problem-Based Learning Using E-Module: Does It Effect on Student's High Order Thinking and Learning Interest in Studying Geography?," *Journal of Technology and Science Education*, vol. 13, no. 3, pp. 613–631, 2023.
[13] M. A. Kurniawan and S. Amin, "Enhancing Student Interest and Learning Outcomes Using the Virtual Tour by Web-Based 360 Videos," *Jurnal Teori dan Praksis Pembelajaran IPS*, vol. 10, no. 1, pp. 37–59, Apr. 2025, doi: 10.17977/um022v10i12025p37.
[14] B. Shermukhammadov, "Creativity of a Teacher in an Innovative Educational Environment.," *Journal of Higher Education Theory & Practice*, vol. 22, no. 12, p. 126, Sep. 2022, doi: 10.33423/jhetp.v22i12.5468.
[15] Y. Yustina, W. Syafii, and R. Vebrianto, "The Effects of Blended Learning and Project-Based Learning on Pre-Service Biology Teachersâ€™ Creative Thinking through Online Learning in the Covid-19 Pandemic," *Jurnal Pendidikan IPA Indonesia*, vol. 9, no. 3, pp. 408–420, Sep. 2020, doi: 10.15294/jpii.v9i3.24706.
[16] J. Hickman, "Spatial Thinking and GIS: Developing and Assessing Student Competencies," *International Research in Geographical and Environmental Education*, vol. 32, no. 2, pp. 140–158, Apr. 2023, doi: 10.1080/10382046.2022.2138172.
[17] K. Atit, D. H. Uttal, and M. Stieff, "Situating Space: Using a Discipline-Focused Lens to Examine Spatial Thinking Skills," *Cogn. Research*, vol. 5, no. 1, p. 19, Apr. 2020, doi: 10.1186/s41235-020-00210-z.
[18] P. Purwanto, S. Utaya, B. Handoyo, S. Bachrı, D. Yulistiya, and S. Amin, "The Spatial Thinking Ability Students on the Character of Urban and Rural Environments in Solving Population Problems," *Review of International Geographical Education Online*, vol. 11, no. 3, pp. 0–0, Aug. 2021, doi: 10.33403/rigeo.877708.
[19] M. Nursa'ban, K. Kumaıdı, and M. Mukmınan, "Factors of Critical Spatial Thinking for a Geography Metacognition Assessment in Indonesian Senior High Schools," *Review of International Geographical Education Online*, vol. 10, no. 2, pp. 186–204, Apr. 2020, doi: 10.33403/rigeo.686050.
[20] J. A. McLaughlin and J. M. Bailey, "Students Need More Practice with Spatial Thinking in Geoscience Education: A Systematic Review of the Literature," *Studies in Science Education*, vol. 59, no. 2, pp. 147–204, Jul. 2023, doi: 10.1080/03057267.2022.2029305.
[21] R. S. Salam, N. Nurfaika, S. Koem, and F. Rubama, "Kemampuan Berpikir Spasial Peserta Didik Menggunakan Citra Google Earth Pada Mata Pelajaran Geografi di SMA Negeri 2 Gorontalo," *Geosfera: Jurnal Penelitian Geografi*, vol. 2, no. 2, pp. 56–61, Dec. 2023, doi: 10.37905/geojpg.v2i2.22569.
[22] N. Adzani, I. Setyasih, and M. V. R. Ningrum, "Kemampuan Berpikir Spasial Siswa SMA Negeri di Kota Balikpapan," *geoedusains: Jurnal Pendidikan Geografi*, vol. 4, no. 1, pp. 45–52, Sep. 2023, doi: 10.30872/geoedusains.v4i1.1687.
[23] R. Alvia, D. Hermon, S. Anwar, and A. Yulfa, "Analisis Pengetahuan Berfikir Spasial Siswa Kelas X dan XII IPS Pada Pelajaran Geografi di SMA Pertiwi 2 Padang," *Jurnal Pendidikan Tambusai*, vol. 8, no. 1, pp. 8028–8033, Jan. 2024, doi: 10.31004/jptam.v8i1.13596.
[24] J. Carneiro, P. Alves, G. Marreiros, and P. Novais, "Group Decision Support Systems for Current Times: Overcoming the Challenges of Dispersed Group Decision-Making," *Neurocomputing*, vol. 423, pp. 735–746, Jan. 2021, doi: 10.1016/j.neucom.2020.04.100.

[25] R. Zatarain-Cabada, M. L. Barrón-Estrada, B. A. Cárdenas-Sainz, and M. E. Chavez-Echeagaray, "Experiences of Web-Based Extended Reality Technologies for Physics Education," *Computer Applications in Engineering Education*, vol. 31, no. 1, pp. 63–82, 2023, doi: 10.1002/cae.22571.
[26] Y. Shi, Y. Ma, J. MacLeod, and H. H. Yang, "College Students' Cognitive Learning Outcomes in Flipped Classroom Instruction: A Meta-Analysis of the Empirical Literature," *J. Comput. Educ.*, vol. 7, no. 1, pp. 79–103, Mar. 2020, doi: 10.1007/s40692-019-00142-8.
[27] Z. Yu, M. Gao, and L. Wang, "The Effect of Educational Games on Learning Outcomes, Student Motivation, Engagement and Satisfaction," *Journal of Educational Computing Research*, vol. 59, no. 3, pp. 522–546, Jun. 2021, doi: 10.1177/0735633120969214.
[28] S. Sulyanah, F. N. Hasanah, and R. S. Untari, "Application of Web Based Learning to Measure Students Learning Interest," *J. Phys.: Conf. Ser.*, vol. 1764, no. 1, p. 012099, Feb. 2021, doi: 10.1088/1742-6596/1764/1/012099.
[29] L. Astuti, Y. Wihardi, and D. Rochintaniawati, "The Development of Web-Based Learning Using Interactive Media for Science Learning on Levers in Human Body Topic," *Journal of Science Learning*, vol. 3, no. 2, pp. 89–98, 2020.
[30] T. M. Kuo, C.-C. Tsai, and J.-C. Wang, "Linking Web-Based Learning Self-Efficacy and Learning Engagement in Moocs: The Role of Online Academic Hardiness," *The Internet and Higher Education*, vol. 51, p. 100819, Oct. 2021, doi: 10.1016/j.iheduc.2021.100819.
[31] J. Ignacio and H.-C. Chen, "The Use of Web-Based Classroom Gaming To Facilitate Cognitive Integration in Undergraduate Nursing Students: A Mixed Methods Study," *Nurse Education in Practice*, vol. 46, p. 102820, Jul. 2020, doi: 10.1016/j.nepr.2020.102820.
[32] S.-C. Cheng, G.-J. Hwang, and P.-Y. Chen, "Facilitating Creativity, Collaboration, and Computational Thinking in Group Website Design: A Concept Mapping-Based Mobile Flipped Learning Approach," *International Journal of Mobile Learning and Organisation*, vol. 18, no. 2, pp. 169–193, Jan. 2024, doi: 10.1504/IJMLO.2024.137613.
[33] Sugiyono, *Metode Penelitian Pendidikan: (Pendekatan Kuantitatif, Kualitatif dan R&D)*, 27th ed. Alfabeta, 2022.
[34] J. W. Creswell and J. D. Creswell, *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Thousand Oaks, CA: SAGE Publication Inc., 2018.
[35] N. T. Huynh and B. Sharpe, "An Assessment Instrument to Measure Geospatial Thinking Expertise," *Journal of Geography*, vol. 112, no. 1, pp. 3–17, 2013, doi: 10.1080/00221341.2012.682227.
[36] E. Purwanto, *Evaluasi Proses dan Hasil dalam Pembelajaran, Aplikasi dalam Bidang Studi Geografi*. Malang: UM Press, 2005.
[37] M. S. J. Maftuh, U. S. Lawal, M. Ade, A. V. Lama, and A. F. Adzim, "Understanding Learning Strategies: A Comparison Between Contextual Learning and Problem-Based Learning," *Educazione: Journal of Education and Learning*, vol. 1, no. 1, pp. 54–65, Dec. 2023, doi: 10.61987/educazione.v1i1.496.
[38] A. N. Rangkuti, *Statistik untuk Penelitian Pendidikan*. Medan: Perdana Publishing, 2015. Accessed: Jul. 12, 2024. [Online]. Available: https://repo.uinsyahada.ac.id/953/
[39] H. Fortuna and H. Saputra, "Pengaruh Penggunaan Web-Gis (Web Based Geographic Information System)Terhadap Kecerdasan Spasial Siswa Pada Mata Pelajaran Geografi," *EL-JUGHRAFIYAH*, vol. 3, no. 2, Art. no. 2, Jan. 2024, doi: 10.24014/jej.v3i2.28728.
[40] M. Nyokro, S. Lusi, S. Risklaritas, F. Muhammad, and D. M. Dedy Miswar, "Teaching geography using Web-GIS to improve students' spatial thinking ability," *Cendikia : Media Jurnal Ilmiah Pendidikan,* vol. 14, no. 1, Art. no. 1, Sep. 2023.
[41] M. F. Rosetti, B. Valdez, and R. Hudson, "Effect of Spatial Scale on Children's Performance in a Searching Task," *Journal of Environmental Psychology*, vol. 49, pp. 86–95, 2017, doi: 10.1016/j.jenvp.2016.12.004.
[42] F. A. Syaviar, "Pengaruh Model Pembelajaran Earth Science System in The Community (Earthcomm) Berbantuan Citra Google Earth Pada Mata Pelajaran Geografi Terhadap Kemampuan Berpikir Spasial Siswa MAN 3 Kediri," *Jurnal Swarnabhumi : Jurnal Geografi dan Pembelajaran Geografi*, vol. 5, no. 2, Art. no. 2, Aug. 2020, doi: 10.31851/swarnabhumi.v5i2.4156.
[43] G. Hulu and K. Dwiningsih, "Validitas LKPD Berbasis Blended Learning Berbantuan Multimedia Interaktif untuk Melatihkan Visual Spasial Materi Ikatan Kovalen," *UJCEd*, vol. 10, no. 1, pp. 56–65, Jan. 2021, doi: 10.26740/ujced.v10n1.p56-65.
[44] S. K. Kutor, A. Raileanu, and D. Simandan, "Thinking Geographically About How People Become Wiser: An Analysis of the Spatial Dislocations and Intercultural Encounters of International Migrants," *Social Sciences & Humanities Open*, vol. 6, no. 1, p. 100288, Jan. 2022, doi: 10.1016/j.ssaho.2022.100288.
[45] J. Z. Memmase, S. Sumarmi, and P. Purwanto, "Analisis Kemampuan Berpikir Spasial Siswa SMA pada Materi Sistem Informasi Geografi Ditinjau dari Perbedaan Gender," *GEOGRAPHY : Jurnal Kajian, Penelitian dan Pengembangan Pendidikan*, vol. 12, no. 2, pp. 779–792, Sep. 2024, doi: 10.31764/geography.v12i2.24956.
[46] M. Choiri *et al.*, "Pengaruh EarthComm Berbantuan Aplikasi Windy terhadap Berpikir Spasial dalam Memecahkan Masalah Perubahan Iklim Global," Sep. 2024, doi: 10.23887/jippg.v4i3.
[47] J. Z. Memmase and P. Purwanto, "Model Earthcomm Berbantuan Google Earth Pro: Pengaruhnya Terhadap Kemampuan Berpikir Spasial Mendalam pada Materi Penelitian Geografi," *GEOGRAPHY : Jurnal Kajian, Penelitian dan Pengembangan Pendidikan*, vol. 12, no. 1, pp. 580–594, Apr. 2024, doi: 10.31764/geography.v12i1.21845.
[48] S. J. L. and T. C. Reeves, "Edgar Dale and the Cone of Experience," Jan. 2017, Accessed: Jul. 10, 2024. [Online]. Available: https://pressbooks.pub/lidtfoundations/chapter/edgar-dale-and-the-cone-of-experience/
[49] A. H. Brown, *The Essentials of Instructional Design: Connecting Fundamental Principles with Process and Practice, Third Edition*, 3rd ed. Routledge, 2015. doi: 10.4324/9781315757438.
[50] D. W. Johnson, R. T. Johnson, and K. A. Smith, "Cooperative Learning: Improving University Instruction by Basing Practice on Validated Theory," *Journal on Excellence in College Teaching*, vol. 25, pp. 85–118, 2014.
[51] M. Aliman, Budijanto, Sumarmi, K. Astina, R. E. Putri, and M. Arif, "The Effect of Earthcomm Learning Model and Spatial Thinking Ability on Geography Learning Outcomes," *Journal of Baltic Science Education*, vol. 18, no. 3, p. Continuous, 2019, doi: https://doi.org/10.33225/jbse/19.18.323.
[52] A. Yani, A. Mulyadi, M. Ruhimat, and M. Ruhimat, "Contextualization of Spatial Intelligence: Correlation Between Spatial Intelligence, Spatial Ability, and Geography Skills," *Journal of Baltic Science Education*, vol. 17, no. 4, p. Continuous, 2018, doi: https://doi.org/10.33225/jbse/18.17.564.

[53] N.-A. Nguyen, O. Muniz-Solari, D. Đặng Tiên, and T. Nguyen, "Reviewing Spatial Thinking in Geography Textbooks Questions from The Perspective of Spatial Thinking," *IOP Conference Series: Earth and Environmental Science*, vol. 338, p. 012042, Nov. 2019, doi: 10.1088/1755-1315/338/1/012042.
[54] N. Nofirman, "Studi Kemampuan Spasial Geografi Siswa Kelas XII SMA Negeri 6 Kota Bengkulu," *Jurnal Georafflesia: Artikel Ilmiah Pendidikan Geografi*, vol. 3, no. 2, pp. 11–24, 2018.
[55] T. D. Aulia, "Pentingnya Teknologi dalam Inovasi Pendidikan," May 04, 2023, *OSF*. doi: 10.31237/osf.io/y2aru.
[56] A. Davoodi, "Digital echoes of heritage: toward a culturally balanced pedagogy in technology-enhanced bilingual education," *JME*, vol. 18, no. 1/2, pp. 192–205, Apr. 2024, doi: 10.1108/JME-10-2023-0107.
[57] C. Fuller and N. Multak, "The Role of Technology in Patient Education," *Physician Assistant Clinics*, Jul. 2024, doi: 10.1016/j.cpha.2024.05.001.
[58] A. Y. Rukmana, S. Supriandi, and R. Wirawan, "Penggunaan Teknologi dalam Pendidikan: Analisis Literatur Mengenai Efektivitas dan Implementasi," *Jurnal Pendidikan West Science*, vol. 1, no. 07, Art. no. 07, Jul. 2023, doi: 10.58812/jpdws.v1i07.541.
[59] B. Zhang and W. Jiang, "Research on the Application Value of Multimedia-Based Virtual Reality Technology in Drama Education Activities," *Entertainment Computing*, vol. 50, p. 100667, May 2024, doi: 10.1016/j.entcom.2024.100667.