JURNAL geografi

https://jurnal.unimed.ac.id/2012/index.php/geo/article/view/72371
https://doi.org/ 10.24114/jg.v18i2.72371 - (Vol 18, No 2 – 2026)
Available at http://jurnal.unimed.ac.id/2012/index.php/geo
e-issn (2549-7057) & p-issn (2085-8167)

Improving Students' Spatial Thinking Skills Through the Integration of Project-Based Learning with Google My Maps

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ARTICLE INFO

Article History:
Received: January 26, 2026
Revision: July 02, 2026
Accepted: July 22, 2026

Keywords:
Project-Based Learning,
Google My Maps,
Spatial Thinking,
Digital Mapping

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ABSTRACT

Students' spatial thinking ability is one of the important competencies in geography learning; however, in practice, this ability remains underdeveloped, so learning innovations are needed to improve spatial thinking skills. This study aims to analyze the effectiveness of integrating Project Based Learning with Google My Maps in improving students' spatial thinking ability. This study used a Quasi-Experimental method with a one-group pre-test and post-test design. The population of this study was tenth-grade students of SMA Negeri 1 Parakan, with the sample being class X-6, selected through purposive sampling technique. Data collection in this study was carried out using observation, test, questionnaire, and documentation techniques. The analysis techniques used in this study were the Paired T-Test, N-Gain, Cohen's d, classical completeness analysis of 75%, and student response analysis. The paired t-test results obtained a Sig. (2-tailed) value of 0.001, indicating a significant improvement in students' spatial thinking ability. Classical completeness reached 92%, exceeding the established criterion of 75%. Student response to the learning was classified as positive, with a percentage of 78.4%, while the N-gain calculation of 61.8% falls into the fairly effective category, and Cohen's d of 2.64 falls into the large effect category. Based on these findings, the integration of Project Based Learning with Google My Maps is proven to be fairly effective in improving students' spatial thinking ability in geography learning.

INTRODUCTION

Education plays a strategic role in the progress of a nation, particularly in the era of globalization and the Industrial Revolution 4.0 (Suharini & Prasadi, 2020; Hanipah, 2023). In order to deeply understand various geographical concepts, students need to develop their spatial thinking ability optimally (Hidayanti et al., 2019; Nisa et al., 2021). Spatial thinking ability is an important aspect of geography education, as it reflects a way of thinking grounded in the understanding of location, distribution, and spatial relationships among phenomena on the earth's surface (Dewi et al., 2021).

Spatial thinking ability is implemented through the processes of visualization, orientation, and understanding of spatial, enabling students to analyze information and comprehend geospheric phenomena from a spatial perspective (Putra et al., 2021; Bachri et al., 2020; Sari et al., 2024). Understanding spatial thinking ability encompasses several indicators that represent geospheric phenomena spatially. These indicators include spatial concepts (spatial primitive, simple spatial, and complex spatial), tools of representation, and reasoning processes (input, processing, and output) (Jo & Bednarz, 2011).

The orientation of spatial thinking is universal in nature and can be applied by students in addressing various spatial problems encountered in everyday life. Therefore, enhancing spatial thinking ability becomes a crucial matter in understanding geographical phenomena and developing a deeper comprehension within the context of geography education (Aliman et al., 2020; Emilia et al., 2023).

Empirical evidence suggests that students' spatial thinking ability remains low (Buana & Putra, 2023). This inadequacy makes geography learning less meaningful. Based on previous research findings, this condition is influenced by the use of less engaging learning methods, limited use of instructional media, and students' lack of familiarity with producing tangible outcomes in learning activities. As a result, students have not been actively engaged in the learning process, leading to low learning outcomes and underdeveloped student skills (Fatmawati et al., 2023; Kurniawan & Triawang, 2021; Cao et al., 2023). This condition subsequently contributes to a decline in learning activity and students' capacity for absorption, which in turn hinders the development of spatial thinking ability (Asiyah et al., 2020).

On the other hand, the current geography learning process has not yet optimally utilized technology, particularly in developing spatial thinking ability as the core of geographical science. Although geospatial technologies such as Geographic Information Systems (GIS), Google Earth, Google My Maps, and other digital mapping applications have been proven effective in accelerating and deepening students' spatial understanding, teachers' access to these technologies remains limited. Consequently, the use of technology is often restricted to static visualization media and has not been employed for in-depth data analysis and exploration activities (Hilman & Mainaki, 2020; Kurniawan et al., 2020; Listiqowati, 2025). Google My Maps is a web-based tool that enables users to create, edit, and share custom maps by adding various elements such as points, lines, polygons, text, photos, and other data into a digital map (Kiss J. & Nunez, 2018).

Based on preliminary data observations and interviews with a Geography teacher at SMA Negeri 1 Parakan regarding the learning process in the mapping topic for grade X, it was found that students' spatial thinking ability has not yet developed optimally. This condition is attributed to learning methods that remain limited to manual mapping using paper media, in which students only draw maps by copying existing ones without engaging in in-depth spatial analysis. Although manual mapping activities can provide an understanding of map elements, this approach is less capable of training students to dynamically manage geospatial information, which is an essential competency in the 21st century.

On the other hand, various studies have demonstrated that the use of digital technology in geography education can enhance students' spatial thinking ability (Collins, 2018). A study by Medani et al., (2022) entitled "The Effect of Guided Discovery Learning Model Assisted by Google My Maps on the Spatial Thinking Ability of Students at SMAN 1 Singosari" found that the application of Google My Maps integrated with the guided discovery learning model had a positive effect on improving students' spatial thinking ability. Meanwhile, Rizqy & Suharto, (2025) revealed that the implementation of Project Based Learning assisted by ArcGIS had a significant effect on the spatial thinking ability of senior high school students. Their study further explained that the use of Geographic Information System (GIS)-based media through a project-based approach was able to provide students with direct hands-on experience in spatial data management and map creation.

Based on the above description, there is a research gap in that no study has specifically integrated Project-Based Learning with Google My Maps as a medium to improve students' spatial thinking ability in geography learning. Through this approach, students not only understand mapping concepts theoretically but are also actively involved in information processing and its application through project-based digital mapping activities. These activities are expected to strengthen students' spatial thinking ability more optimally.

The novelty of this study lies in its effort to integrate Project-Based Learning with Google My Maps, which provides students with the opportunity to design, input, and analyze spatial data collaboratively through authentic project work, rather than merely observing pre-made maps. Through this approach, students gain a more contextual and participatory learning experience, allowing their spatial thinking ability, particularly in terms of orientation, relationships, and spatial visualization, to develop through digital mapping practices directly connected to geographical phenomena in their surroundings. Therefore, it is essential to examine how effective the integration of Project-Based Learning with Google My Maps is in enhancing students' spatial thinking ability. This research is expected to offer valuable insights for advancing technology-based geography instruction, particularly in efforts to strengthen students' spatial thinking skills.

RESEARCH METHODS

Research Design and Location

This study was conducted at SMA Negeri 1 Parakan; the school is located in Tegalroso Village, Parakan Subdistrict, Temanggung Regency **(Figure 1).** This study employed a quantitative approach with a Quasi-Experimental design using the one-group pre-test post-test design. In this design, a single group is given treatment as the experimental group, without involving a control group (Hastjarjo, 2020). The treatment refers to the integration of Project-Based Learning with Google My Maps through digital mapping activities to improve students' spatial thinking ability, as shown in **Table 1** below.

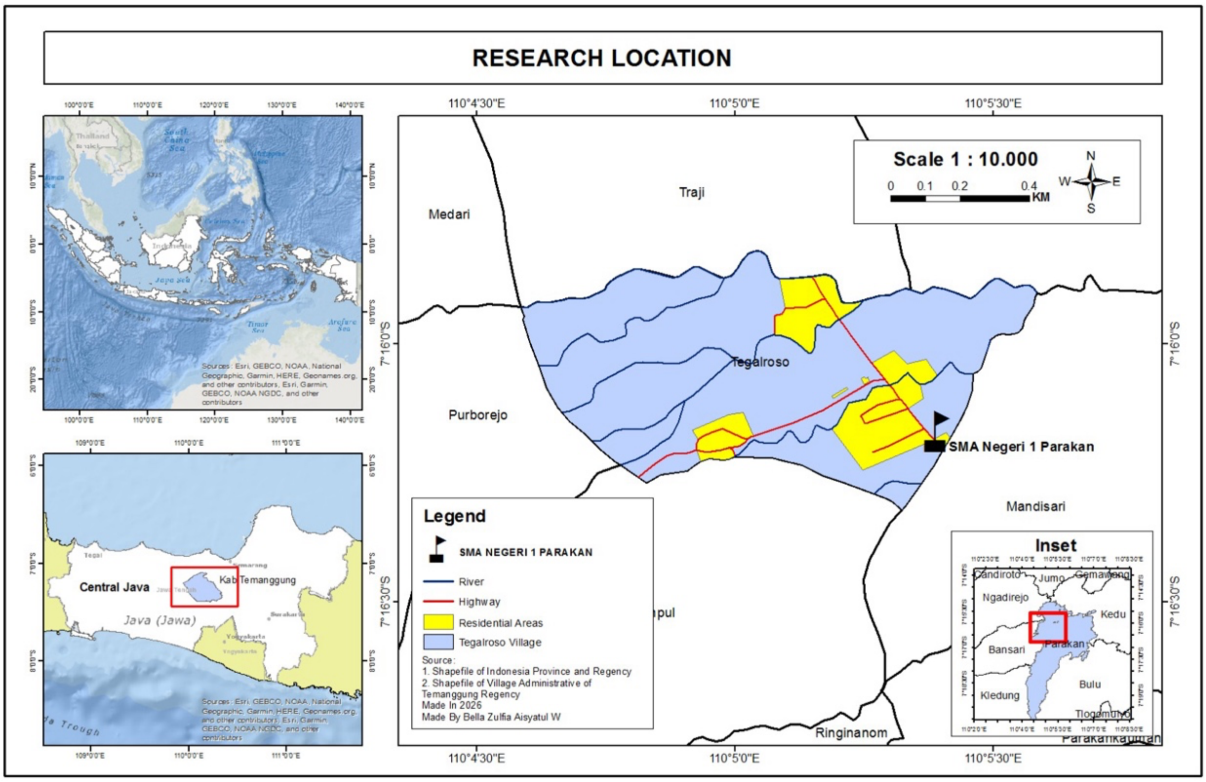

Figure 1. Research Location (Source: Data Processing, 2026)

Table 1. One Group Pre-test and Post-test Design

Pre-test	Treatment	Post-test
T 1	X	T 2

(Source : Sugiyono, 2020)

T1	: Pre-test or initial test
Treatment	: The treatment given to students in the form of the integration of Project-Based Learning with Google My Maps
T2	: Post-test or final test

Population and Sample

The population of this study comprised 324 tenth-grade students at SMA Negeri 1 Parakan for the 2025/2026 academic year, spread across nine classes (X-1 to X-9), with 36 students in each class. This population was selected because mapping material is part of the tenth-grade curriculum, thereby providing data relevant to the research objectives. The sample was determined using the purposive sampling method, taking into account students' learning outcomes, under the assumption that these scores reflect students' general prior academic ability. This assumption was considered representative as it covered the entire class population in the study, allowing the sample selection to be conducted in a measurable and accountable manner. Accordingly, the class with the lowest average learning outcome score was selected as the experimental class in order to determine the extent to which the implementation of Project-Based Learning with Google My Maps could improve students' spatial thinking ability. The researcher used class X-6 as the research sample, which had the lowest average Mid-Semester Assessment (PTS) score compared to other classes, at 57.8.

Research Procedure

This study was conducted through three stages: preparation, implementation, and evaluation. In the preparation stage, the researcher conducted preliminary observations at SMA Negeri 1 Parakan, developed research instruments and tools, prepared basic map instructional materials, and validated the research instruments. The validation results showed that the teaching module obtained a feasibility percentage of 95.83% from expert lecturers and 93.75% from teachers, while the Google My Maps guidebook obtained 96.43%, all of which fell into the "very feasible to use" category and were consistent with the learning outcomes, learning objectives, and the characteristics of geography material oriented toward spatial thinking ability.

The implementation stage was carried out over three meetings, applying the Project-Based Learning model integrated with Google My Maps based on the project-based learning syntax proposed by Nurhidayah & Pratama, (2024), which includes: 1) formulating essential questions, 2) designing a project plan, 3) creating a project schedule, 4) monitoring project activities and progress, 5) testing or assessing the results, and 6) reflecting on and evaluating the learning experience. At this stage, students were given a pre-test and post-test to measure their spatial thinking ability, and carried out a digital mapping project as part of the learning activities. Subsequently, in the evaluation stage, an analysis was conducted on the pre-test and post-test results and student responses. The results of this analysis were used to assess the effectiveness of integrating Project-Based Learning with Google My Maps in improving students' spatial thinking ability.

Data Collection Techniques

The data collection techniques used in this study included tests, observation, student response questionnaires, and documentation studies. The test was used to measure students' spatial thinking ability through multiple-choice questions covering the spatial thinking indicators proposed by Jo & Bednarz, (2011), as presented in **Table 2**. Observation was conducted to assess student activity and the implementation of project-based learning during the digital mapping activities. The questionnaire was used to determine students' responses to the implementation of Project-Based Learning with Google My Maps, while documentation served as supporting data.

Table 2. Spatial Thinking Ability Indicators

Indicator	Sub Indicator	Description
Spatial Concept (Concept of Space)	Non-spatial Spatial primitives Simple spatial Complex-spatial	Students' ability to understand spatial concepts encompassing location, region, distribution, and pattern
Tools of Representation (Tool Representation)	Use Non Use	Students' ability to use Google My Maps as a tool in representing spatial concepts
Reasoning Process (Reasoning)	Input	Students' ability to identify spatial patterns
	Processing	Students' ability to analyze spatial patterns
	Output	Students' ability to produce a digital map product

(Source : Jo & Bednarz, 2011)

Data Analysis Techniques

The data analysis techniques employed in this study consisted of the Paired T-Test, N-Gain, Cohen's d, a classical mastery analysis with a 75% threshold, and an analysis of student responses toward the learning process. The Paired T-Test was applied to examine whether a significant difference existed between students' pre-test and post-test scores before and after the learning model was implemented. N-Gain was used to assess the degree of improvement in students' spatial thinking ability relative to the maximum achievable score. Cohen's d, meanwhile, was employed to determine the practical magnitude of the treatment's effect size, ensuring that the evaluation was not based on statistical significance alone. Classical mastery was determined to be achieved if at least 75% of all students obtained learning outcomes that met or exceeded the Minimum Completeness Criteria (KKM) established by the school.

Validity and Reliability Test

Before being tested, the test instrument was reviewed by the supervising lecturer to ensure the suitability of the test items with the spatial thinking ability indicators according to Jo & Bednarz, (2011), as presented in Table 2. The test instrument was then subjected to validity and reliability testing using SPSS version 27. The validity of the test items was assessed using the Pearson Product-Moment correlation. Of the 35 items tested, 25 items (71.43%) were found to be valid, while 10 items (28.57%) were found to be invalid. The valid items were subsequently used as the research instrument. Some items were found to be invalid due to unclear item formulation, which made them difficult for students to understand, resulting in selected answers that did not reflect the intended meaning of the questions. In addition, item invalidity was also influenced by some students answering randomly or carelessly without first reading and understanding the intent of the questions. Meanwhile, the reliability test of the instrument using Cronbach's Alpha formula yielded a value of 0.756, categorized as high, indicating that the tested items were considered reliable for use in the research.

RESULTS AND DISCUSSION

This study aims to analyze the effectiveness of integrating Project-Based Learning with Google My Maps in improving students' spatial thinking ability. The effectiveness of the learning was measured through three indicators, namely: 1) classical mastery of 75%, 2) students' positive responses to the learning process, and 3) learning outcomes as reflected in the pre-test and post-test scores (Aurora & Sholeh, 2023).

Classical Mastery of 75%

Students' learning mastery was measured based on the Minimum Completeness Criteria (KKM) of ≥75 established by SMA Negeri 1 Parakan. This KKM was set in accordance with the principle of criterion-referenced assessment, namely interpreting student learning outcomes based on predetermined competency achievement standards, as regulated in Permendikbudristek Number 21 of 2022 concerning Education Assessment Standards. In addition, a class is considered to have achieved classical mastery if the percentage of students reaching the KKM meets the minimum threshold of ≥75% (Aurora & Sholeh, 2023; Sudarmini, 2023). Students' mastery of learning outcomes related to spatial thinking ability was determined from the pre-test and post-test results. The test administered to students consisted of 25 multiple-choice items, as shown in **Table 3** below.

Table 3. Data of Learning Outcome Completeness Results for Spatial Thinking Skills

Test	Number of Students		N	% Complete	% Incomplete
	Complete	Incomplete			
Pre-Test	7	29	36	19%	81%
Post-Test	33	3	36	92%	8%

(Source: Research Data, 2025)

Based on these calculations, 7 students (19%) achieved mastery on the pre-test, while 29 students (81%) did not. On the post-test, 33 students (92%) achieved mastery, while 3 students (8%) did not. There was an increase of 73 percentage points, from 19% to 92%, in spatial thinking learning outcomes following the treatment involving the integration of Project-Based Learning with Google My Maps in geography learning on basic mapping material, a result that exceeds the minimum classical mastery threshold of 75%.

This 73 percentage point increase is also consistent with the findings of Rahayu et al., (2022), who reported that Project-Based Learning integrated with digital platforms can significantly improve student learning outcomes. Meanwhile, the 3 students (8%) who did not achieve mastery reflect individual variation in digital literacy and the pace of adaptation to geospatial technology, which had not yet reached an optimal level. This is in line with Yahya & Suryani, (2024), who stated the need for differentiated learning based on students' cognitive styles to enable students to absorb learning more optimally.

Students' Responses to the Learning Process

Student responses were analyzed to identify students' level of interest, the effectiveness of the model and media applied, and the ease of using Google My Maps throughout the learning process. These results are presented in **Table 4**.

Table 4. Results of Student Responses

Description	Result
Number of Students	36
Average Score	78,4
Percentage	78,4%
Category	Positive

(Source: Research Data, 2025)

Based on the calculations of the student response questionnaire regarding the learning process integrating Project-Based Learning with Google My Maps on basic mapping material, an average result of 78.4% was obtained, which falls into the positive category. These results indicate that the majority of students gave positive responses to the learning process integrating Project-Based Learning with Google My Maps in digital mapping activities within geography learning on basic mapping material. This is in line with Qur'ani & Kurniawan (2021), who stated that learning is an activity that provides stimulus and response, thereby creating a positive effect. The positive student responses indicate that the learning process implemented through the integration of Project-Based Learning with Google My Maps was able to increase students' interest, motivation, and learning outcomes, which is also consistent with Heristama & Sholeh (2022), who stated that positive responses indicate that the learning process is able to improve student learning outcomes.

On the other hand, students' responses regarding the ease of use of Google My Maps tended to be less favorable. Some students experienced difficulties in operating certain features, such as layer settings. This condition is presumably due to students' limited prior experience in using WebGIS-based mapping applications. Therefore, intensive guidance and structured training on the use of Google My Maps are needed to help students better understand its operational workflow. This finding is consistent with Sari et al., (2025), who found that the implementation of geospatial technology in learning depends not only on awareness of its importance, but also on users' level of knowledge and skills. Without adequate technical mastery, the integration of geospatial technology in learning cannot proceed optimally. Accordingly, the difficulties experienced by students in using Google My Maps indicate that technical the idea that competence is an important factor that needs to be strengthened in the learning process.

Learning Outcomes of Spatial Thinking Ability

In this study, spatial thinking ability in the cognitive domain was the main focus measured through students' pre-test and post-test results in project-based learning integrated with Google My Maps. The findings Trahorsch et al., (2026) revealed that students often experience misconceptions not only conceptually but also spatially, particularly in determining the location of geographical phenomena.

This condition indicates that students' spatial thinking ability remains limited to descriptive understanding and has not yet been able to accurately integrate concepts with spatial representation. This is relevant to the findings of the present study, in which students similarly showed difficulties in identifying locations, distribution patterns, and relationships between phenomena in the pre-test results, which then improved following the treatment involving the integration of Project-Based Learning with Google My Maps.

To ensure the validity of the subsequent analysis, the spatial thinking ability data were first tested for normality using the Kolmogorov-Smirnov test at determine whether the pre-test and post-test data followed a normal distribution. The criterion applied was that a significance value (sig.) greater than 0.05 indicated normally distributed data, while a value of 0.05 or less indicated otherwise. The complete results of this normality test for both the pre-test and post-test data are presented in **Table 5**.

Table 5. Normality Test Results

One-Sample Kolmogorov-Smirnov Test	
Asymp. Sig. (2-tailed)c	Result 0.091

(Source: Research Data, 2025)

Based on the Kolmogorov-Smirnov normality test, the significance value for both the pre-test and post-test data was 0.091, exceeding the 0.05 threshold, indicating that the data were normally distributed. Having confirmed normality, the analysis proceeded with a paired t-test on students' spatial thinking ability data, conducted to determine whether a significant difference existed between the two means being compared in this case, the pre-test and post-test results. The paired t-test results are presented in **Table 6** and **Table 7**.

Table 6. Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-Test	67.3333	36	7.31339	1.21890
	Post-Test	87.2777	36	7.79010	1.29835

(Source: Research Data, 2025)

Table 7. Paired Samples Test Results

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pre-Test & Post-Test	-19.9444	8.51889	1.41981	-23.21571	-17.45096	-14.321	35	0.001

(Source: Research Data, 2025)

The paired sample t-test results revealed a significant difference between the pre-test and post-test mean scores, rising from 67.3333 to 87.2777, a mean difference of 19.9444. Furthermore, the paired differences test yielded a significance value (2-tailed) of 0.001, which is below 0.05. These results indicate a significant difference in the improvement of spatial thinking ability, as reflected in the increased post-test mean scores of students in the experimental class. Based on these findings, the integration of Project-Based Learning with Google My Maps on basic mapping material had a significant effect on improving spatial thinking ability.

After conducting the normality test and the paired sample t-test on the data obtained, the results showed that the data were normally distributed. This was followed by an N-Gain test to determine the level of effectiveness of integrating Project-Based Learning with Google My Maps in digital mapping activities within geography learning on basic mapping material. According to, Hake, (1998) there are three categories of N-Gain scores: an N-Gain value > 0.7 is categorized as highly effective, a value of 0.3 < N-Gain < 0.7 is categorized as fairly effective, and a value < 0.3 is categorized as less effective or ineffective. The results of the N-Gain calculation are presented in **Table 8**.

Table 8. N-Gain Test Results

	N	Minimum	Maximum	Mean	Std. Deviation
N-Gain_Score	36	0.00	1.00	0.6183	0.23759
N-Gain_Persen	36	0.00	100.00	61.8315	23.75865
Valid N (listwise)	36				

(Source: Research Data, 2025)

Based on the N-Gain calculation, the score obtained from the pre-test and post-test data on students' spatial thinking learning outcomes was 0.6183, with a standard deviation of 0.23759. This N-Gain score falls within the range of 0.3 ≤ N-Gain ≤ 0.7, placing it in the moderate effectiveness category. Based on the N-Gain percentage calculation, the result reached 61.8%, which falls into the fairly effective category. This value can be understood contextually, considering the technical digital literacy barriers experienced by some students and the limited time allocation of only three meetings. Nevertheless, this achievement still indicates that the use of digital media in mapping instruction is considered more effective than conventional media. This is in line with (Collins, 2018), who found that students using digital maps demonstrated better spatial thinking achievement than students using paper maps, particularly in terms of orientation and spatial visualization.

Furthermore, research on the use of digital mapping platforms to improve spatial thinking ability is actually not new, as demonstrated by Medani et al., (2022), who applied Google My Maps within a guided discovery learning model, and Rizqy & Suharto, (2025), who applied ArcGIS-assisted Project-Based Learning to high school students' spatial thinking ability. However, this study offers a different contribution, namely the integration of Project-Based Learning with Google My Maps that specifically emphasizes student autonomy in designing projects, group collaboration in authentic project work, and a final product in the form of an authentic digital map resulting from the mapping of public facilities in students' surrounding environment a combination that has not been widely explored at the senior high school level, particularly using the Google My Maps platform, which is simpler and more accessible than professional GIS software such as ArcGIS.

Quantitatively, this difference in approach is also reflected in the N-Gain results. The N-Gain in this study was 61.8%, higher than that of Rizqy & Suharto, (2025), who also applied Project-Based Learning but obtained an N-Gain of 53.5%, both falling into the fairly effective category. This difference indicates that integrating Google My Maps within a Project-Based Learning framework, which actively involves students in the digital mapping process, can make a greater contribution to improving spatial thinking ability than ArcGIS-assisted Project-Based Learning. This finding is consistent with Putra et al., (2021), who demonstrated that technology-based Project-Based Learning consistently produces greater learning improvement than conventional learning.

To further strengthen these findings, the analysis proceeded with calculating the effect size using Cohen's d, which measures the magnitude of the effect produced by integrating the Project-Based Learning model with Google My Maps on the improvement of students' spatial thinking ability. Cohen, (1988) classifies effect size into four categories: d < 0.20 as trivial, 0.20–0.50 as small, 0.51–0.80 as medium, and d ≥ 0.80 as large. The results of the Cohen's d calculation are shown in **Table 9**.

Table 9. Results of Cohen's d Calculation

Samples Effect Sizes	
	Point Estimate
Cohen's d	2,64

(Source: Research Data, 2025)

Based on the calculation of effect size using Cohen's d, a value of 2.64 was obtained, which falls into the large effect category (Cohen, 1988).This indicates that the integration of Project-Based Learning assisted by Google My Maps had a substantial influence on improving students' spatial thinking ability, both statistically and practically.

The effect size in this study is considerably larger than that reported in several other studies applying Project-Based Learning. For example, Anggraini et al., (2025), who applied a PjBL-STEM model combined with Design Thinking to students' critical thinking ability, obtained an effect size of only 0.51, categorized as medium. Similarly, Rosiliant et al., (2025), who applied a Project-Based Learning model assisted by Wordwall media to student learning outcomes in the IPAS (Natural and Social Sciences) subject, obtained a Cohen's d value of 1.4, which, although already classified as a large effect, remains lower than the Cohen's d value of 2.64 obtained in this study. This difference indicates that integrating Project-Based Learning with Google My Maps in digital mapping activities produced a stronger impact, likely due to students' direct involvement in processing and visualizing real spatial data rather than merely understanding abstract concepts.

Overall, the three indicators of learning effectiveness proposed by Aurora & Sholeh, (2023) were met, namely classical mastery of 92%, which exceeded the 75% threshold, student responses in the positive category with a percentage of 78.4%, and a statistically significant improvement in learning outcomes (Sig. = 0.001), with an N-Gain of 61.83% and a Cohen's d of 2.64. The fulfillment of these three indicators consistently demonstrates that the integration of Project-Based Learning with Google My Maps is not only effective in improving students' academic achievement, but also able to foster student engagement and positive attitudes toward the learning process, particularly at SMA Negeri 1 Parakan. Accordingly, this learning approach is worth considering as an innovative and contextual alternative strategy for geography instruction, oriented toward strengthening students' spatial thinking ability at the senior high school level.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTION

BZAW contributes to the conceptualization of the study, research design, data collection and analysis, and the drafting of the original manuscript in its entirety. **MS** contributes as the supervisor, providing guidance in the development of the theoretical framework, refinement of the methodology, and supervision throughout the research process. **DLS** contributes to the comprehensive evaluation of the research substance, critical assessment of the theoretical framework, and overall assessment of the manuscript's feasibility as examiner 1. **EK** contributes to the evaluation of the methodology and interpretation of the research findings as examiner 2. **ES** contributes to the final review of the manuscript, including the refinement of the discussion and conclusion sections, as examiner 4. All authors have read and approved the final version of the manuscript.

CONCLUSION

The integration of Project-Based Learning with Google My Maps through digital mapping activities proved fairly effective in improving the spatial thinking ability of tenth-grade students at SMA Negeri 1 Parakan. This is based on three effectiveness indicators: (1) classical mastery on the post-test reached 92%, exceeding the minimum threshold of 75%; (2) student responses fell into the positive category (78.4%); and (3) a statistically significant improvement was demonstrated by the paired t-test (sig. = 0.001), with an N-Gain of 61.83% (moderate category) and a Cohen's d effect size of 2.64 (very large).

These findings imply that Google My Maps is worth integrating routinely into geography learning, particularly for material requiring spatial understanding, by utilizing authentic project contexts within students' real-world environments as a meaningful and relevant strategy. Nevertheless, this study has several limitations, including a research design that used only one group without a comparison group, as well as a limited number of meetings, which means it cannot yet fully demonstrate a cause-and-effect relationship. Therefore, further research is recommended to employ a quasi-experimental design with two groups, namely an experimental group implementing Project-Based Learning with Google My Maps and a control group using conventional learning. In addition, a WebGIS training session should be added before the learning activities begin to minimize technical digital literacy barriers, and the study should be extended to other geography topics such as the environment, population, or disaster mitigation to strengthen causal claims and broaden the generalizability of the findings.

FUNDING

This research does not receive external funding.

ETHICAL STATEMENT

This study obtained permission to conduct research from SMA Negeri 1 Parakan. Student participation in this study was voluntary, with consent from the subject teacher and homeroom teacher, and students' identities were kept confidential in the reporting of the research results.

ACKNOWLEDGMENT

The author would like to express his deepest gratitude to all parties who have supported the research process, starting from data collection and data processing.

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