



ADVANCING SPATIAL CULTURE SKILLS THROUGH PROJECT-BASED LEARNING SUPPORTED BY GOOGLE EARTH

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Article History

Received : 11/04/2026

Revised : 18/06/2026

Accepted : 20/07/2026

Keywords:

Spatial culture, Project-based learning, Google earth, Deep learning, Geography instruction.

Abstract. Geography instruction still faces challenges, particularly low student engagement due to the dominance of conventional expository methods. This condition limits students' ability to actively analyze human and environment relationships and contributes to low spatial culture skills. This study aims to examine the effect and evaluate its effectiveness of a project-based learning model combined with google earth on students' spatial culture skills. The study employed a quantitative quasi-experimental method with a pretest–posttest control group design. Samples were selected through simple random sampling and divided into control (expository model) and experimental (project-based learning with google earth) classes. Data were collected using a validated spatial culture test, supported by observations, interview, documentation, and analyzed using t-test and N-Gain Score. The results show a significant difference between the two groups ($\text{sig} .000 < .05$), indicating that project-based learning with google earth influences students' spatial culture skills. The experimental class demonstrated higher improvement, with mean scores increasing from 55.67 (pretest) to 84.00 (post test), and an N-Gain of .7332 (73%) categorized as high. In conclusion, project-based learning integrated with google earth is effective in enhancing students' spatial culture skills in geography learning.

How to Cite: Putra, B. P., & Prihadi, S. (2026). ADVANCING SPATIAL CULTURE SKILLS THROUGH PROJECT-BASED LEARNING SUPPORTED BY GOOGLE EARTH. *Prima Magistra: Jurnal Ilmiah Kependidikan*, 7(3), 669-683. <https://doi.org/10.37478/jpm.v7i3.7847>

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Publisher:

Program Studi PGSD Universitas Flores. Jln. Samratulangi,
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INTRODUCTION

Learning is an interactive communication tool between a teacher and students (Kurniawan, 2025). Learning is one of the most important aspects of human life. Through learning, an individual can acquire knowledge, skills, and attitudes during the interactive process (Waluyaningtyas et al., 2025). Appropriate learning guides a student through a process that fosters positive changes in attitudes across cognitive, affective, and psychomotor dimensions (Djaledje, 2023). Twenty-first-century education demands a transformation in the learning process one that is no longer teacher-centered but student-centered (Liza & Firdaus, 2025). Learning is expected to develop critical, creative, collaborative, and communicative thinking skills as part of the core competencies that students must possess in the 21st century (Fahri, 2025). One of the subjects taught in high schools in the 21st century is geography.

Geography is the study of the Earth and its natural, physical, and human environments, encompassing human activities as well as the reciprocal relationships and interactions between humans and the environment on scales ranging from local to global (Yli-Panula et al., 2020). Consequently, geography education can foster students' concern for their surrounding environment (Zaus et al., 2026). In the 21st century, geography education is also required to develop 4C skills (Efriyanti & Annas, 2025), as the field of geography is fundamentally grounded in spatial concepts. One branch of geography is cultural geography (Davies & Gilmartin, 2002). Cultural geography is a branch of human geography that studies the interactions between humans and their environment, as well as the impact of these interactions on local culture and identity (Longhurst, 2007).

Ideally, cultural geography education is designed to encourage students to develop a deeper understanding of how to analyze and describe the relationship between humans and their environment (Winiarti et al., 2022). Spatial culture is a foundational principle linking culture and space, encompassing how humans organize space both physically and socially to meet their needs (Peponis, 2024). Spatial culture theory challenges the assumption of a direct and linear

relationship between the functional definition of social space and the meaning of place (Gieryn, 2000). Spatial culture thinking skills are a component of spatial literacy, focusing on how individuals consciously and responsibly understand, interpret, and interact with space and culture (Adams, 2023). This involves integrating spatial thinking with local cultural values in interpreting and utilizing space (Adams, 2023). Spatial culture enables students to engage with diverse cultural contexts, fostering empathy, respect, and effective communication across cultural boundaries (Cresswell, 2008). However, field conditions indicate that students' spatial culture skills remain relatively low.

Students' low spatial reasoning skills result from teachers' suboptimal use of varied instructional models and their failure to utilize learning media appropriate to students' needs (Yanti et al., 2025). Instruction is still conducted using an expository model, in which learning remains teacher-oriented and teacher-dominated (Fitriati & Williyan, 2025). Consequently, this leads students to become passive due to their limited involvement in the learning process. This situation results in students having fewer opportunities to develop their spatial thinking skills (Ninghardjanti et al., 2025). Thus, students' spatial culture skills are classified as low, even though these skills are crucial in daily life (Nugroho et al., 2025). For example, students are asked to interact with their surroundings regarding the topic of Indonesia's strategic position and its impact on economic and socio-cultural life, but they do not do so, resulting in low spatial culture skills (Syarif et al., 2024). To address this issue, instructional development is required. One prerequisite for instructional development is that instruction must be tailored to the characteristics of the learners (Akib et al., 2020).

The project-based learning model is an effective way to provide students with hands-on experiences to understand cultural geography concepts through a project (Zaus et al., 2026). Engaging students in projects allows them to observe, experience, and interact with various cultural environments (Kokotsaki et al., 2016). This can enhance students' understanding and appreciation of cultural diversity (Winiarti et al., 2022). Project-based learning can make the learning process more enjoyable and meaningful because students can explore the taught material further based on real-life experiences and apply them to a project (Supriatna & Yunengsih, 2023). In the project-based learning process, students are given a timeframe to work on projects related to real-world topics (Winiarti et al., 2022). Implementing project-based learning can spark students' interest in understanding geography because projects enhance their creativity in grasping the subject matter and make the learning environment more enjoyable (Nurdin et al., 2021^a).

Through students' experiences in working on projects, they are able to apply theoretical knowledge to practical situations, fostering a deeper understanding of cultural geography concepts (Rahmadi et al., 2024). In its development, a learning approach that emphasizes direct experience and active student participation has become highly relevant (Ghorai, 2025). The project-based learning model is an effective way to provide students with direct experience through a project to understand geographic concepts (Putri, 2020). The use of google earth as a learning tool supports the learning process and enhances students' comprehension of the material (Zhong et al., 2009). The use of google earth as an interactive learning medium to improve students' geographic skills represents an advancement in educational technology (Alfatikh et al., 2020).

Several studies confirm that project-based learning is effective due to its contextual nature, which enhances students' understanding and learning outcomes. For instance, Nabang et al. (2021) found that this approach significantly influences student achievement by making learning more relevant and engaging. The project-based learning influences students' prior knowledge, characteristics, and motivation, as group-based learning boosts their enthusiasm, enjoyment, and willingness to participate in project activities. Similarly, Nurhadi et al. (2018) research by found that students' problem-solving skills in geography can be improved by using the project-based learning. The steps of this model are considered appropriate for training problem-solving skills. Students can develop identification, analysis, solution, and evaluation skills through the project-based learning. Students' thinking styles need to be considered in problem-solving skills. Not all

students who think divergently have better problem-solving skills than those who think convergently, and vice versa; therefore, in learning and problem-solving, there should be a balance between divergent and convergent thinking styles.

A study conducted by [Wiranto & Selegi \(2021\)](#) aimed to analyze the level of effectiveness of implementing the creative problem solving and project-based learning models on students' learning outcomes in social studies. The results showed that both learning models were proven effective in improving student learning outcomes. A study conducted by [Safira et al. \(2024\)](#) examined how a project-based learning model using infographics and google eEarth affects students' spatial thinking. The findings indicate that this approach significantly influences both the critical spatial thinking of 10th-grade students and the spatial culture of 12th-grade students at different state high schools. A study conducted by [Kencana et al. \(2025\)](#) examined differences in geographic literacy and tested the effectiveness of a problem-based learning model integrated with google earth for 10th-grade students. The findings confirm that this approach effectively improves both geographic literacy and spatial culture skills, with google earth serving as a key supplemental tool. In a study conducted by [Syarif et al. \(2024\)](#) aimed to examine the impact of a field trip-based project-based learning model on students' creative thinking and cultural literacy, while also introducing a new combined dependent variable called spatial culture. The findings suggest that this model effectively fosters innovative learning experiences and enhances spatial culture, which is measured through indicators like atmosphere, character, enclosure, and space.

Based on the issues outlined above, it is evident that the instructional models currently used to support students' spatial culture skills are not yet optimal. Through an innovation in geography instruction specifically, the implementation of an instructional model capable of creating active, collaborative, and meaningful learning experiences, it is hoped that student engagement can be enhanced while simultaneously developing their spatial culture skills. Therefore, this study focuses on the application of a relevant learning model to address these issues and to improve the quality of geography learning in schools. This study aims to test and analyze the differences and effectiveness of the treatments between classes using the project-based learning accompanied by google earth and the expository learning model.

This study makes theoretical and practical contributions to the development of geography education. Theoretically, the research findings can serve as a scientific reference regarding the development of spatial culture skills, a concept that is still relatively new and has not been extensively studied in the context of geography instruction in Indonesia, particularly through the application of a project-based learning model aided by google earth. Practically, this study is expected to provide teachers with an alternative approach to implementing geospatial technology-based learning to enhance students' spatial culture skills, as well as to serve as a basis for schools to develop innovative geography teaching methods that meet the demands of the 21st century.

RESEARCH METHODS

This study employs a quantitative approach using a quasi-experimental design. The specific quasi-experimental design utilized is a nonequivalent control group design with a pretest-posttest design only. The reseach design is presented in [Table 1](#).

Table 1. Nonequivalent Control Group Design

E1	O1	X1	O3
E2	O2	X2	O4

As shown in [Table 1](#), students in each class were first given a pretest (O1 and O2) to measure their spatial culture skills. The pretest was administered to determine the initial condition and whether there was a difference between the experimental class group and the control class group regarding the tested material. Next, students in the first class (O1) were treated with the implementation of the project-based learning model combined with the google earth (X1) over a total of 4 learning sessions. Students in the second class (O2) were assigned the expository learning model (X2) over a total of 4 learning sessions. After both classes received the same number of sessions, students in each class were given Posttests (O3 and O4) to assess their final spatial culture proficiency.



The population in this study consisted of all 12th-grade students at state high school 1 Teras who were taking the geography course during the odd semester of the 2025/2026 academic year, totaling 216 students. This population was divided into 6 classes, namely class 12 E, 12 F, 12 G, 12 H, 12 I, and 12 J. The sample used in this study consisted of all students in class 12 F and 12 H at state senior high school 1 Teras, with 36 students in each class. The data collection method involved the use of a test, which was administered to assess improvements in students' spatial culture skills regarding the topic of Indonesia's strategic location and its impact on economic and socio-cultural life. The test used in this study was designed to measure students' spatial culture skills (Açikgöl et al., 2023). The test developed for this study consisted of 24 multiple-choice questions. The questions were formulated based on the learning outcomes for the relevant subject matter. By aligning the test questions with the learning outcomes, it is hoped that the learning objectives can be achieved (Hayati et al., 2020).

The tests were administered to both classes using the same test instrument, and the results will be analyzed to test the validity of the research hypothesis (Kanbir et al., 2018). The tests were conducted at predetermined times: before the intervention and after the intervention, which serve as the determinants of the research outcomes (Wang, 2015). The pretest aims to determine the extent of students' understanding of the material before the intervention, while the posttest aims to assess students' understanding of the material after the intervention through the application of the project-based learning model combined with the google earth (Sitohang & Damanik, 2024).

The data analysis techniques used included the t-test and N-Gain score test. The t-test is intended to examine the effect of the independent variable on the dependent variable; the test used in this study is the independent samples t-test, which is used to test the difference in mean values between two unrelated sample groups (Lee, 2014). The N-Gain score test was used to determine the level of effectiveness of a treatment administered to both class groups (Sesmiyanti et al., 2019). In this study, the N-Gain score to identify the effectiveness categories of the project-based learning model combined with google earth in enhancing students' spatial culture. Using the following N-Gain criteria: N-Gain < 40: ineffective, N-Gain 40–55: less effective, N-Gain 56–75: moderately effective, and N-Gain > 76: effective (Valente, 2025).

RESULTS AND DISCUSSION

The students' initial ability results were obtained from a pretest administered before the implementation of the classroom intervention. The questions pretest consisted of 24 questions, including 8 simple multiple-choice, 9 complex multiple-choice, and 7 multiple-choice-multiple-answer. The pretest was administered before the intervention began in both the experimental and control classes. The scores obtained by the students from the pretest served as an indicator of their initial ability. Pretest statistical analysis is presented in Table 2.

Table 2. Descriptive Statistical Analysis Pretest Score

	N	Mean	Max	Min	Standard Deviation	Var
Pretest Experimental Class	36	55.67	64	45	5.020	25.200
Pretest Control Class	36	57.08	65	45	5.195	26.993

As shown in Table 2, the pretest scores of the experimental class, consisting of 36 students, ranged from a high of 64 to a low of 45. Based on this score range, the mean was 55.67 with a standard deviation of 5.020 and a variance of 25.200. Meanwhile, the pretest results for the control class, which consisted of 36 students, had a highest score of 65 and a lowest score of 45. Based on this range of scores, the mean was 57.08 with a standard deviation of 5.195 and a variance of 26.993. The frequency distribution of the pretest scores was determined by calculating the number of class values and class intervals to facilitate the grouping of scores. Frequency distribution pretest score range is presented in Table 3.

Table 3. Calculation of Class Values and Class Intervals Pretest Score

	N	Max	Min	Value Range	Number of Classes	Class Interval
Pretest Experimental Class	36	64	45	19	7	3
Pretest Control Group	36	65	45	20	7	3



As shown in Table 3, the pretest score ranges for students in both classes is presented in Table 4.

Table 4. Pretest Interval Scores

Pretest Experimental Class			Pretest Control Class		
Interval	Absolute Frequency	Relative Frequency (%)	Interval	Absolute Frequency	Relative Frequency (%)
45–47	4	11.1%	45–47	2	5.6%
48–50	2	5.6%	48–50	4	11.1%
51–53	3	8.3%	51–53	4	11.1%
54–56	12	33.3%	54–56	4	11.1%
57–59	7	19.4%	57–59	9	25.0%
60–62	5	13.9%	60–62	8	22.2%
63–65	3	8.3%	63–65	5	13.9%

As shown in Table 4, it can be seen that the frequency distribution of pretest scores in the experimental class consists of 7 intervals with a range of 3. The pretest scores of students in the control class were most frequently found in the 54–56 interval, with 12 students. Meanwhile, the lowest score was in the 48–50 interval, with 2 students. Meanwhile, the frequency distribution of pretest scores in the control class consists of 7 intervals with a range of 3. The pretest scores of students in the control class were most concentrated in the 57–59 interval, with 9 students. Meanwhile, the lowest score was in the 45–47 interval, with 2 students. Diagram of average pretest score is presented in Figure 1.

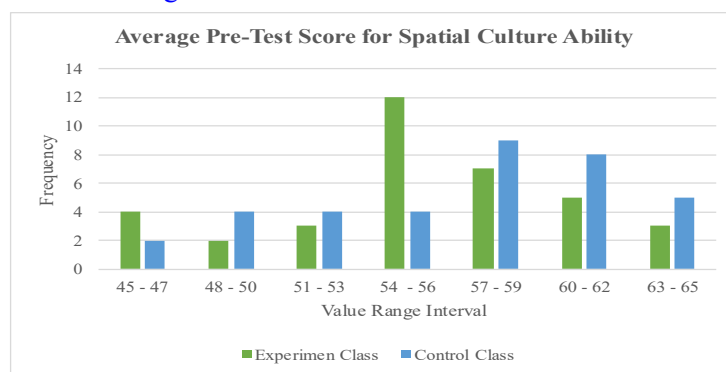


Figure 1. Diagram of Average Pretest Scores

The final achievement results of the students were obtained from the posttest administered to the students after the implementation of the treatment in the classroom. The posttest consisted of 24 questions, including 8 simple multiple-choice, 9 complex multiple-choice, and 7 multiple-choice-multiple-answer. The posttest was administered after the intervention was implemented in both the control and experimental classes. The scores obtained by students from the posttest serve as an indicator of their final proficiency. Posttest statistical analysis is presented in Table 5.

Table 5. Descriptive Statistical Analysis Posttest Score

	N	Mean	Maximum	Minimum	Standar Deviation	Var
Pretest Experimental Class	36	88.03	96	73	5.511	30.371
Pretest Control Group	36	79.03	92	60	5.843	34.112

As shown in Table 5, the posttest scores of the experimental class, consisting of 36 students, ranged from a high of 96 to a low of 73. Based on this score range, the mean was 88.03 with a standard deviation of 5.511 and a variance of 30.371. Meanwhile, the posttest scores for the control class, which consisted of 36 students, had a highest score of 92 and a lowest score of 60. Based on this score range, the mean was 79.03 with a standard deviation of 5.843 and a coefficient of variation of 34.142. The frequency distribution of posttest scores was determined by calculating the number of class intervals to facilitate score grouping. Frequency distribution posttest score

range is presented in Table 6.

Table 6. Calculation of Class Values and Class Intervals Posttest Score

	N	Max	Min	Value Range	Number of Classes	Class Interval
Posttest Experimental Class	36	96	73	19	7	3
Posttest Control Group	36	92	60	32	7	5

As shown in Table 6, the score intervals for the post-test of students in both classes is presented in Table 7.

Table 7. Posttest Score Intervals

Posttest for the Experimental Class			Posttest Control Class		
Interval	Absolute Frequency	Relative Frequency (%)	Interval	Absolute Frequency	Relative Frequency (%)
73–76	2	5.6	60–64	1	2.8%
77–80	2	5.6	65–69	2	5.6%
81–84	5	13.9	70–74	1	2.8%
85–88	10	27.8	75–79	13	36.1%
89–92	10	27.8	80–84	15	41.7%
93–96	7	19.4	85–89	3	8.3%
97–100	0	0	90–94	1	2.8%

As shown in Table 7, it can be seen that the frequency distribution of posttest scores in the experimental class consists of 7 intervals with a range of 4. The posttest scores of students in the control class were most frequently found in the 85–88 and 89–92 intervals, with 10 students in each. Meanwhile, the lowest scores were in the 73–76 and 77–80 intervals, each with 2 students. The frequency distribution of posttest scores in the control class consists of 7 intervals with a range of 5. The posttest scores of students in the control class were most concentrated in the 80–84 interval, with 15 students. Meanwhile, the lowest scores were in the 60–64, 70–74, and 90–94 intervals, with only 1 student each. Diagram of average posttest score is presented in Figure 2.

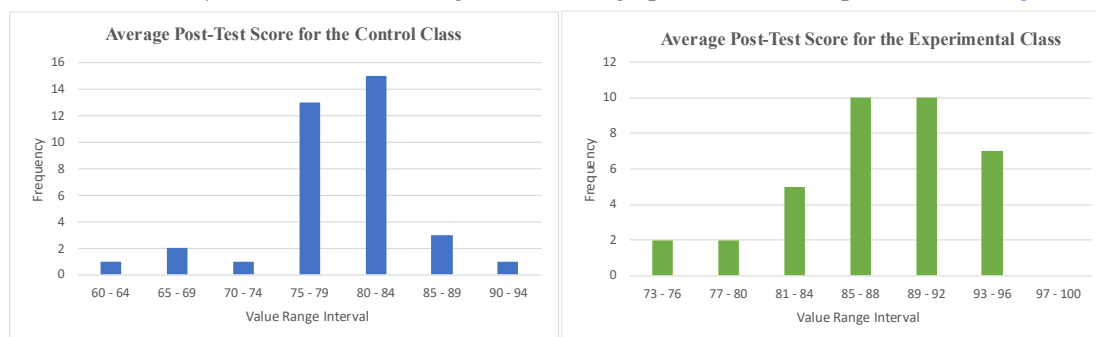


Figure 2. Diagram of Average Posttest Scores

As shown in Figure 2, the final achievement scores of the students were assessed through a posttest administered after the intervention was implemented in both the control and experimental classes. In the experimental class, the score ranges of 85–88 and 89–92 were predominant, whereas in the control class, the score range of 80–84 was predominant. This indicates that the experimental class had a higher average score than the control class. This indicates that the students' abilities in both classes changed from before the intervention. Comparison of scores experimental class and control class is presented in Table 8.

Table 8. Comparison of Scores Between the Experimental Class and the Control Class

Description	Experimental Class		Control Class	
	Pretest	Posttest	Pretest	Posttest
Average	55.67	88.03	57.08	79.03
Highest Value	45	96	45	92
Lowest Score	64	73	65	60
Number of Students	36	36	36	36

As shown in Table 8, it can be seen that the average final spatial culture score of students in the experimental class was higher, at 88.03 compared to the control class, which had an average of 79.03. This indicates that the experimental class experienced positive changes as a result of the classroom intervention provided. Diagram of comparison average experimental class and control class is presented in Figure 3.

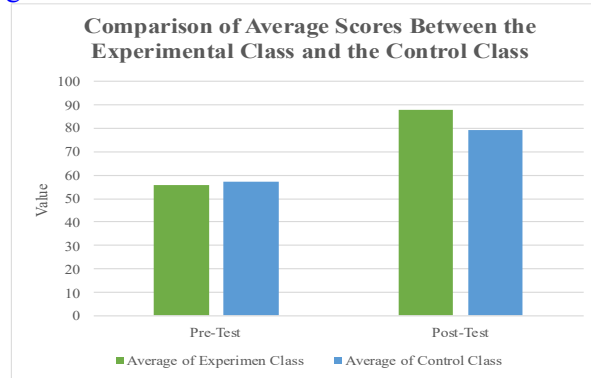


Figure 3. Comparison of Average Scores Between the Experimental and Control Classes

To calculate the level of spatial culture proficiency, the posttest scores of students in both classes were used (Pansri et al., 2024). The average spatial culture proficiency score was derived from the combined results of all questions sharing the same indicator (Verma, 2017). The average was calculated by first standardizing the weight of all questions using the formula average score divided by the maximum score (Efriyanti & Annas, 2025). After the average question scores were obtained, the average spatial culture indicator was calculated using the formula the average number of questions divided by the total number of questions (Siregar, 2023). After the average indicator was obtained, the indicator score was calculated by multiplying the average result by 10. Once the indicator scores were obtained, the spatial culture ability levels of students in the experimental and control classes were classified. Average spatial culture ability is presented in Table 9.

Table 9. Average Spatial Culture Ability

Spatial Ability	Atmosphere	Character	Enclosure	Space
Experimental Class	85.00	85.00	85.00	81.00
Control Class	71.00	78.00	82.00	74.00

From the average data for each aspect of the students' spatial culture abilities a histogram comparing the average spatial culture abilities of the students as shown in Figure 4.

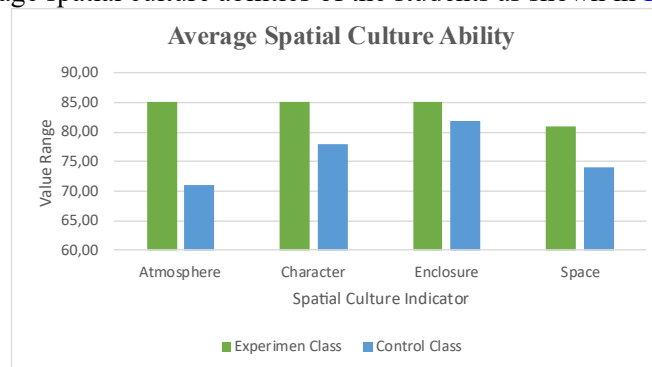


Figure 4. Average Spatial Culture Ability

As shown in Table 9 and Figure 4, it was found that the experimental class using a project-based learning model supplemented with google earth achieved higher average scores than the control class on every indicator. This indicates that students in the experimental class have a better understanding of spatial culture.

The t-test was conducted using the collected data, which was then analyzed using the independent samples t-test method to determine whether the two independent samples had

different mean values (Nurwiani & Trisianti, 2024). In this study, the t-test was conducted using a significance level of 5% (equivalent to .05). The data was analyzed such that if the significance value was $< .05$ a significant difference was present between the two classes; however, if the significance value was $.05$ no significant difference was found between the two classes (Nurwiani & Trisianti, 2024). Hypothesis testing in this study was conducted to determine the t-test (difference) using the Independent Sample t-test on the posttest results. These results were used to determine the magnitude of the difference in changes between the two classes after treatment (Nurwiani & Trisianti, 2024). If the significance value (two-tailed) is $< .05$ then H_0 is rejected and H_1 is accepted (Nurwiani & Trisianti, 2024). T-test result is presented in Table 10.

Table 10. T-Test Results

Variance Equation	T	T-Test Sig. (2-tailed)
Assumed	-6.723	.000
Not Assumed	-6.723	.000

As shown in Table 10, it can be seen that the assumed data shows a 2-tailed significance of .000 or $< .001$ so the test value is $< .05$. Furthermore, the t-test results involved comparing the calculated t-value with the critical t-value. It was found that the calculated t-value was -6.723. By comparing this value with the critical t-value derived from the formula $(\alpha/2);(df) = (.05/2);(70)$, the critical t-value was determined to be 1.954. This indicates that there is a difference in the comparison of mean values between the control class and the experimental class, so it can be concluded that H_0 is rejected and H_1 is accepted. In other words, there is a difference in students' spatial culture ability after being given a treatment using the project-based learning model accompanied by google earth compared to the expository model for measuring the level of students' spatial culture ability in geography learning.

In this study, the effectiveness of the project-based learning model was assessed using the N-Gain score method (Mahulae et al., 2023). To determine the level of effectiveness of the project-based learning model, refer to the N-Gain score summary table under the "mean" column (Hake, 1999). The criteria for determining the N-Gain score test are divided into two categories: by percentage, they are divided into four categories $<40\%$ ineffective, 40% – 55% less effective, 56% – 75% moderately effective, and $>76\%$ effective; while by decimal value, they are divided into three categories, $g > .7$ (high), $.3 < g < .7$ (moderate), and $g < .3$ (low) (Hake, 1999). The result of the N-Gain score test is presented in Table 11.

Table 11. Results of the N-Gain Score Test

Descriptive Statistics			
Control Group	Mean	Experimental Class	Mean
N-Gain Score Test	.4964	N-Gain Score Test	.7332
N-Gain Score Test (%)	49.64	N-Gain Score Test (%)	73.32

As shown in Table 11, which presents the results of the hypothesis test on effectiveness, it can be seen that the mean value for the control class was .4964 or 49%, indicating that the test results fall into the moderately ineffective category. Meanwhile, the experimental class had a mean value of .7332 or 73%, which falls into the highly effective category. This demonstrates that the use of the project-based learning model combined with google earth in the experimental class was more effective than the use of the expository model in the control class in this study.

This study involved 72 students in two classes: class 12 H as the control group and class XII F as the experimental group. The two classes received different treatments. Class 12 H, as the control group, was taught using the expository model in the learning process, as had been done in previous lessons. Class 12 F, on the other hand, was taught using the project-based learning model, supplemented with google earth. These treatments were administered with the aim of developing students' spatial culture skills as reflected in the final assessment results (Metoyer et al., 2015). The application of these different treatments resulted in differing final skill levels between the control and experimental classes, with both classes exhibiting significantly different spatial culture skill scores (Bartoschek & Schwering, 2022). Both classes were found to have different average spatial culture competencies, supported by the results of statistical tests indicating that the project-based learning model combined with google earth is effective and

highly impactful in enhancing the spatial culture competencies of Grade 12 students at state high school 1 Teras. This conclusion is based on the results of hypothesis testing regarding the effect of the learning model on students' spatial culture abilities, which showed that the first hypothesis resulted in the rejection of H_0 and the acceptance of H_1 , as the significance probability was .000 ($<.05$). Meanwhile, regarding the second hypothesis, the test of the effectiveness of the learning model on students' spatial culture skills, the statistical results showed that H_0 was rejected and H_1 was accepted, as the effectiveness of the treatment in the experimental class was significantly higher at 73% compared to the control class, which was only 49%.

Before the intervention, each student was given a pretest consisting of 24 multiple-choice questions. The multiple-choice formats used were simple multiple-choice with a maximum score of 1, categorical multiple-choice with a maximum score of 5, and multiple-choice with multiple answers with a maximum score of 4. The pretest was administered to assess the students' initial abilities before the intervention was implemented in the control and experimental classes. Based on the pretest scores completed by the students, not a single student's score reached the minimum passing criteria of 75.00. For the control class, not a single student achieved the minimum score, with an average score of only 57.08 the highest score being 65.00 and the lowest 45.00. Similarly, in the experimental class, none of the students' scores reached the minimum passing score of 75.00. In the experimental class, none of the students achieved the minimum score, with an average score of only 55.67, the highest score being 64.00 and the lowest 45.00.

After being given the pretest, most students felt that the questions were difficult and encouraged them to think harder to answer them. These student responses provide an initial indication that the questions stimulated students to think more analytically (Yavich, 2025). The posttest was administered after the intervention in each class. The posttest questions were similar to the pretest questions, with nearly identical formats, numbers, and content. The posttest was used to assess whether there were significant changes in students' spatial culture skills following the intervention using the implemented learning model. Both the pretest and posttest questions covered the topic of Indonesia's strategic position for Grade 12. The questions were designed to align with the spatial culture indicators. The results of the posttest were analyzed to determine whether there were significant changes, thereby assessing the effectiveness of the model in developing students' spatial culture skills in both the control and experimental classes.

The project-based learning model was implemented in the experimental class to compare its effectiveness against the expository model used by teachers at state high school 1 Teras. Throughout the learning process using this model, students in both the control and experimental classes participated with enthusiasm and high motivation. A pretest was administered as an initial stimulus before students were exposed to the learning model in the classroom. The implementation of the project-based learning model combined with google earth is effective and highly impactful for enhancing students' spatial culture skills. This is because the syntax of the project-based learning model, when combined google earth, can train, refine, and optimize students' spatial culture skills, particularly in the aspects of atmosphere, character, enclosure, and space. The intervention for both the control and experimental classes was structured into the same number of sessions, namely 4 face-to-face meetings. Each session followed the syntax established in the in-depth lesson plan designed beforehand. The implementation of the project-based learning model assisted by google earth demonstrated a systematic learning process focused on strengthening the connection between geographical conditions and the culture developing in a particular region.

The project-based learning model combined with google earth represents an innovation in geography instruction in the classroom, resulting in a new, more innovative, and engaging learning approach for students (Nurdin et al., 2021b). Observations indicate that students are more motivated during the learning process. According to students, the structure of the project-based learning model with google earth encourages them to be more active in seeking information to solve problems through project-based learning activities (Farhan & Ardiansyah, 2023). Students' activities in seeking information are conducted through practical exercises and discussions, fostering a habit of collaborative work among students, while also granting them the

freedom to construct their own knowledge and training them to develop spatial culture (D'Urso et al., 2023).

In addition to project activities requiring practical skills, project-based learning also involves writing up results and conclusions in the form of a lab report. The lab report serves as the final document of the analysis of cultural exploration using google earth. Thus, it can be said that the lab report reflects the knowledge constructed within the students' minds (Torres-Peña et al., 2024). Through the lab report, students can more easily store various pieces of information while also making it easier for them to recall the steps of the cultural exploration lab using google earth (Jaeger, 2024). These conveniences will eventually help students build spatial culture more easily and quickly.

The project-based learning model plays a significant role in optimizing the spatial culture skills of Grade 12F students compared to Grade 12H students using the expository model, as Grade 12F performed better in solving geography problems on the posttest. Project-based learning is a project-based instructional model designed to guide and encourage student engagement in learning, enabling students to understand the subject matter through the experience of working on projects (Funke, 2022). This model requires students to possess and hone strong communication and collaboration skills within groups (Zaus et al., 2026). In the experimental class using the project-based learning model, the researcher guided students to solve problems related to how Indonesia's geographical conditions impact the social and cultural aspects of society. Through this problem-solving process, students further developed their spatial culture analysis skills. This differs from the control class, where learning is dominated by lectures and conventional group problem-solving activities.

A comparison of the average scores for students' spatial culture skills can be seen in the average spatial culture indicators. In questions with the first indicator atmosphere students can understand the ambiance of a space through social interaction. The atmosphere indicator measures students' emotional perceptions and sensory interactions with a space (Adams, 2023). For this indicator, students are required to possess the ability to understand the atmosphere of a space (Adams, 2023). Through the questions on the atmosphere indicator, it is expected that students can describe a dynamic space based on its atmosphere (Adams, 2023). The control class achieved an average score of 71.00 falling into the moderate category. Meanwhile, the experimental class achieved an average score of 85.00 falling into the high score category. This indicates that students' spatial culture thinking levels regarding the atmosphere indicator were higher in the experimental class.

In questions with the second indicator character students can assess the uniqueness or identity of a space based on cultural elements (Adams, 2023). The character indicator serves to identify students' ability to distinguish the uniqueness of a space from a cultural perspective (Adams, 2023). For this indicator, students are required to have the ability to observe regarding the distinctive features of a place and how those features shape culture (Adams, 2023). Through the questions under the character indicator, it is hoped that students can recognize cultural values, social functions, and symbols of a space. The control class achieved an average score of 78.00 falling into the high-score category. Meanwhile, the experimental class achieved an average score of 85.00 also falling into the high-score category. This indicates that students' spatial culture thinking levels on this indicator were higher in the experimental class.

In the question regarding the third indicator enclosure, students assess the degree of spatial constraints and how such spaces shape human experiences (Adams, 2023). The enclosure indicator evaluates how students understand the role of spatial boundaries in influencing human behavior (Adams, 2023). For this indicator, students are required to distinguish between spaces and their impact on human behavior and activities. Through the questions on the enclosure indicator, it is hoped that students can understand how spatial design can determine human interaction and mobility (Adams, 2023). The control class achieved an average score of 82.00 falling into the high-score category. Meanwhile, the experimental class achieved an average score of 85.00 also falling into the high-score category. This indicates that students' spatial culture thinking levels regarding this indicator were higher in the experimental class.



In the question regarding the fourth indicator space, students can analyze the use of a space (Adams, 2023). This indicator serves to evaluate students' understanding of the function, meaning, and dynamics of space usage (Adams, 2023). For this indicator, students are required to demonstrate their ability to understand how a space is used, transformed, and interpreted through human activities (Adams, 2023). Through the questions on this indicator, it is expected that students can explain changes in the function of space within a socio-cultural context. The control class achieved an average score of 74.00 falling into the moderate category. Meanwhile, the experimental class achieved an average score of 81.00 falling into the high score category. This indicates that students' spatial culture thinking levels regarding this indicator were higher in the experimental class.

The implementation of the project-based learning model, combined with the use of google earth, is crucial for the teaching and learning process in the classroom, as demonstrated in the experimental group of this study. According to Adams (2023), spatial culture is a concept that describes the relationship between a culture and a space, as well as how humans shape, experience, and give meaning to the spaces they inhabit. Spatial culture must be understood by humans both actively and passively (Peponis, 2024). Actively, when a person is conscious of the use and shaping of space to convey an identity and values; and passively, when the space itself becomes a representation of a culture that has become historically and socially ingrained (Peponis, 2024). Spatial culture is deconstructed and applied to emerging approaches designed to understand a space; thus, spatial culture is beneficial for honing students' adaptive abilities toward an environment, shaping identity and a sense of ownership toward a place, fostering global citizenship, and cultivating intercultural tolerance (Adams, 2023). Through spatial culture, students can be trained to become more adaptive to their environment, developing a sense of ownership toward their homes and surrounding spaces, and fostering awareness of cultural diversity given that Indonesia is a nation with a high value of tolerance, as evidenced by the motto "*Bhineka Tunggal Ika*". Furthermore, spatial culture plays a role in shaping attitudes of tolerance and global citizenship because students are able to understand cultural differences as a result of diverse and interconnected spatial dynamics. Therefore, the role of spatial culture is crucial for students.

Through the concept of spatial culture, students will understand that the cultures created by a given space are diverse, leading them to better appreciate the different cultures that emerge (Wood, 2008). Given these benefits, as time progresses, spatial culture remains highly relevant to geography education. Therefore, integrating the concept of spatial culture into project-based learning and utilizing google earth can serve as an effective strategy to foster students' spatial culture thinking skills.

Based on previous research, many studies have addressed spatial analysis skills; however, no previous studies have examined spatial culture skills. Therefore, this study is classified as an innovative experimental study related to learning models, google earth, and spatial culture skills. In this study, the use of the project-based learning model combined with google earth had a positive impact on students' ability to develop spatial culture skills. Students in the class treated with the project-based learning model combined with google earth demonstrated the ability to collaborate in groups and effectively utilize google earth as a learning aid during classroom instruction. The use of the project-based learning model combined with google earth is an effective approach to utilizing geography learning models and media that equips students with the skills to collaborate and think analytically. This combination has a positive impact on students, particularly those in the 12th grade at SMA Negeri 1 Teras during the 2025/2026 academic year.

CONCLUSIONS AND SUGGESTIONS

This study reveals a difference in students' spatial culture skills between the control class, which used an expository learning model, and the experimental class, which used a project-based learning model. The results show that the average score for spatial culture skills in the control class was 76.00 while in the experimental class it was 84.00. A statistical test using the independent samples t-test yielded a significance value of .000 ($< .05$), indicating that the use of



the project-based learning model combined with google earth has a significant effect on improving students' spatial culture skills. Additionally, the N-Gain test results showed that the control class achieved a score of .4964 (sufficiently effective category), while the experimental class achieved a score of .7332 (highly effective category). Thus, it can be concluded that the implementation of the project-based learning model combined with google earth is more effective than the expository model in improving students' spatial culture skills.

REFERENCES

- Açikgöl, K., Şad, S. N., & Altay, B. (2023). Spatial ability test for university students: Development, validity and reliability studies. *International Journal of Assessment Tools in Education*, 10(1), 76–97. <https://doi.org/10.21449/ijate.1102435>
- Adams, R. (2023). *Designing Spatial Culture*. Routledge. <https://doi.org/10.4324/9781003270393>
- Akib, E., Imran, M. E., Mahtari, S., Mahmud, M. R., Prawiyogy, A. G., Supriatna, I., & Ikhsan, M. H. (2020). Study on implementation of integrated curriculum in Indonesia. *IJORER: International Journal of Recent Educational Research*, 1(1), 39-57. <https://doi.org/10.46245/ijorer.v1i1.24>
- Alfatikh, E. R., Winanti, E. T., Prasetya, S. P., & Budiyanto, E. (2020). Implementing Google Earth to Enhance Student's Engagement and Learning Outcome in Geography Learning. *Geosfera Indonesia*, 5(1), 147. <https://doi.org/10.19184/geosi.v5i1.11987>
- Bartoschek, T., & Schwering, A. (2022). Geotechnology-based Spatial Learning: The Effects on Spatial Abilities and Sketch Maps in an Inter-Cultural Study. *AGILE: GIScience Series*, 3, 1–10. <https://doi.org/10.5194/agile-giss-3-1-2022>
- Cresswell, T. (2008). Space and place (1977): Yi-Fu Tuan. In P. Hubbard, R. Kitchin, G. Valentine (Eds.) *Space and place (1977): Yi-Fu Tuan* (pp. 53-60). SAGE Publications Ltd, <https://doi.org/10.4135/9781446213742.n7>
- Davies, W., & Gilmartin, M. (2002). Geography as a cultural field. In *Geography, culture and education* (pp. 13-30). Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-017-1679-6_2
- Djaledje, A. M. *Efektivitas Model Project Based Learning Pada Mata Pelajaran Geografi di SMA Negeri 8 Kabupaten Sigi* (Skripsi, Universitas Tadulako). <https://repository.untad.ac.id/id/eprint/108740>
- D'Urso, M. G., Burini, F., & Ghisalberti, A. (2023). Challenge Based Learning Geoscience: Student-Oriented Teaching For Digital Mapping. *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, X-5/W1-2023, 11–18. <https://doi.org/10.5194/isprs-annals-X-5-W1-2023-11-2023>
- Efriyanti, L., & Annas, F. (2025). The Application of AI Technology in Vocational High School Curriculum Design Based on Individual Student Skills in Facing the Challenges of the 21st Century Industry. *Jurnal Online Informatika*, 10(2), 453–464. <https://doi.org/10.15575/join.v10i2.1516>
- Fahri, M. R. S. (2025). Pendidikan Inovatif di Abad 21: Mewujudkan Pembelajaran yang Bermakna dan Berkelanjutan. *Jurnal Pendidikan Dasar, Menengah & Kejuruan*, 1, 33–38. <https://artmediapub.id/index.php/JPDMK>
- Farhan, F. I., & Ardiansyah, A. (2023). Modified Project-Based Learning in Geography: A Better Approach. *FOUNDASIA*, 13(2), 70–75. <https://doi.org/10.21831/foundasia.v13i2.57924>
- Fitriati, S. W., & Willian, A. (2025). AI-enhanced self-regulated learning: EFL learners' prioritization and utilization in presentation skills development. *Journal of Pedagogical Research*, 9(2), 22–37. <https://doi.org/10.33902/JPR.202530647>
- Funke, J. O. (2022). Literature Review of Project-based Learning. *Journal of Educational Research and Policies*. [https://doi.org/10.53469/jerp.2022.04\(07\).23](https://doi.org/10.53469/jerp.2022.04(07).23)
- Ghorai, B. (2025). Learning through Experience: A Practical Approach. *International Journal for Multidisciplinary Research*, 7(5). <https://doi.org/10.36948/ijfmr.2025.v07i05.58675>



- Gieryn, T. F. (2000). A Space for Place in Sociology. *Annual Review of Sociology*, 26(1), 463–496. <https://doi.org/10.1146/annurev.soc.26.1.463>
- Hake, R. R. (1999). *Analyzing change/gain scores*. <https://scispace.com/pdf/analyzing-change-gain-scores-2flqldd4zo.pdf>
- Hayati, U., Ediyani, M., Maimun, M., Anwar, K., Fauzi, M. B., & Suryati, S. (2020). Test Technique as a Tool for Evaluation of Learning Outcomes. *Budapest International Research and Critics Institute (BIRCI-Journal): Humanities and Social Sciences*, 3(2), 1198–1205. <https://doi.org/10.33258/birci.v3i2.961>
- Jaeger, A. J. (2024). Google Earth as a Tool for Supporting Geospatial Thinking. *Land*, 13(12), 2218. <https://doi.org/10.3390/land13122218>
- Kanbir, S., Clements, M. A., & Ellerton, N. F. (2017). Research Design and Methodology. In *Using Design Research and History to Tackle a Fundamental Problem with School Algebra* (pp. 115-140). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-59204-6_6
- Kencana, L. A. M., Sugiyanto, S., & Prihadi, S. (2025). Penerapan Model Pembelajaran Problem Based Learning (PBL) disertai Media Google Earth untuk Meningkatkan Kemampuan Literasi Geografi Peserta Didik di SMA Negeri 1 Kartasura. *GEADIDAKTIKA*, 5(2), 162-170. <https://jurnal.uns.ac.id/geadidaktika/article/view/105998>
- Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. *Improving Schools*, 19(3), 267–277. <https://doi.org/10.1177/1365480216659733>
- Kurniawan, W. (2025). Construction of an Intelligent Teacher Assistant System Using the TPACK Framework and Machine Learning to Diagnose Work and Energy Misconceptions. *International Journal of Information and Education Technology*, 15(5), 1084–1102. <https://doi.org/10.18178/ijiet.2025.15.5.2312>
- Lee, H. (2014). t-Tests for Two Means Comparisons. In *Foundations of Applied Statistical Methods* (pp. 63–74). Springer International Publishing. https://doi.org/10.1007/978-3-319-02402-8_3
- Liza, E., & Firdaus, A. (2025). The Application of AI Technology in Vocational High School Curriculum Design Based on Individual Student Skills in Facing the Challenges of the 21st Century Industry. *Jurnal Online Informatika*, 10(2), 453–464. <https://doi.org/10.15575/join.v10i2.1516>
- Longhurst, R. (2007). Geografia cultural. Trobades diferents, trobant la diferència. *Documents d'Anàlisi Geogràfica*, 50, 105–120. <https://doi.org/10.5565/rev/dag.1037>
- Mahulae, P. S., Makahinda, T., Silangen, P. M., & Rampengan, A. M. (2023). Effectiveness of Project Based Learning Model in Learning Evaluation Course in Physics Education Study Programme. *Jurnal Penelitian Pendidikan IPA*, 9 (Special Issue), 1077–1082. <https://doi.org/10.29303/jppipa.v9iSpecialIssue.5891>
- Metoyer, S.K., Bednarz, S.W., Bednarz, R.S. (2015). Spatial Thinking in Education: Concepts, Development, and Assessment. In: Muñiz Solari, O., Demirci, A., Schee, J. (eds) *Geospatial Technologies and Geography Education in a Changing World*. Advances in Geographical and Environmental Sciences. Springer, Tokyo. https://doi.org/10.1007/978-4-431-55519-3_3
- Nabang, O., No, V., Kaluge, L., & Andayani, E. (2021). Pengaruh Model Pembelajaran Project Based Learning, Motivasi Belajar Terhadap Hasil Belajar Mata Pelajaran Geografi. *Jurnal Penelitian Dan Pendidikan IPS*, 15(1), 38–40. <https://ejournal.unikama.ac.id/index.php/JPPPI/article/view/5488>
- Ninghardjanti, P., Umam, M. C., Subarno, A., Winarno, W., Langgi, N. R., & Widodo, J. (2025). Evaluating the impact of AI on the critical thinking skills among the higher education students by combining the TAM model and critical thinking theory. *Frontiers in Education*, 10. <https://doi.org/10.3389/educ.2025.1719625>
- No, V., Kaluge, L., & Andayani, E. (2021). Pengaruh Model Pembelajaran Project Based Learning, Motivasi Belajar Terhadap Hasil Belajar Mata Pelajaran Geografi. *Jurnal Penelitian Dan Pendidikan IPS (JPPPI)*, 15(1), 38–40.



<https://doi.org/https://doi.org/10.21067/jppi.v15i1.5488>

- Nugroho, A. E. J. K., Fitri Samsiyah, I., & Muryani, C. (2025). Analisis Kemampuan Berpikir Spatial Peserta Didik Fase E Sekolah Menengah Atas Negeri 1 Sukoharjo. *La Geografia*, 23(3), 210–223. <https://ojs.unm.ac.id/Lageografia/article/view/70187>
- Nurdin, E. A., Pangastuti, E. I., Puji, R. P. N., Surya, R. A., & Adni, K. R. N. (2021a). Implementation of the use of project-based learning models in the application of online geography learning strategies. *IOP Conference Series: Earth and Environmental Science*, 747(1), 012045. <https://doi.org/10.1088/1755-1315/747/1/012045>
- Nurdin, E. A., Pangastuti, E. I., Puji, R. P. N., Surya, R. A., & Adni, K. R. N. (2021b). Implementation of the use of project-based learning models in the application of online geography learning strategies. *IOP Conference Series: Earth and Environmental Science*, 747(1), 012045. <https://doi.org/10.1088/1755-1315/747/1/012045>
- Nurwiani, & Trisanti, L. B. (2024). Independent Samples T Test And The Mann-Whitney-Wilcoxon Test To Know The Effect Of The Drill Method On Mathematics Learning Outcomes. *Journal of Modern Applied Statistical Methods*, 24(1). <https://doi.org/10.56801/Jmasm.V24.i1.1>
- Pansri, B., Sharma, S., Timilsina, S., Choonhapong, W., Kurashige, K., Watanabe, S., & Sato, K. (2024). Understanding Student Learning Behavior: Integrating the Self-Regulated Learning Approach and K-Means Clustering. *Education Sciences*, 14(12), 1291. <https://doi.org/10.3390/educsci14121291>
- Peponis, J. (2024). *Architecture and Spatial Culture*. Routledge. <https://doi.org/10.4324/9781003396673>
- Putri, R. D. (2020). The Influence of Project Based Learning (PJBL) Learning Model on Spatial Thinking Ability in Class X Geography Learning Eyes in SMA PGRI 2 Palembang. *Journal of Geography Science and Education*, 2(1), 11. <https://doi.org/10.32585/jgse.v2i1.828>
- Rahmadi, M. T., S., Lubis, D. P., Lukitoyo, P. S., & Halim, J. (2024). Analysis of Cultural Geography Learning Concept Design Based on Case Method and Team-Based Project. *KnE Social Sciences*. <https://doi.org/10.18502/kss.v9i2.14922>
- Nurhadi, A. R., Utaya, S., & Handoyo, B. (2018). Pengaruh model project based learning dan gaya berpikir terhadap kemampuan memecahkan masalah mahasiswa Geografi. *Jurnal Pendidikan: Teori, Penelitian, dan Pengembangan*, 3(7), 974-979. <https://doi.org/10.17977/jptpp.v3i7.11372>
- Safira, E. D., Noviani, R., & Rindarjono, M. G. (2024). Pengaruh Model Pembelajaran Project Based Learning Disertai Infografis Terhadap Critical Spatial Thinking Peserta Didik Kelas X SMA N 1 Sukoharjo Tahun Ajaran 2022/2023. *GEADIDAKTIKA*, 4(2), 16. <https://doi.org/10.20961/gea.v4i2.76689>
- Sesmiyanti, S., Antika, R., & Suharni, S. (2019). N-Gain Algorithm for Analysis of Basic Reading. *Proceedings of the Proceedings of the 2nd International Conference on Language, Literature and Education, ICLLE 2019, 22-23 August, Padang, West Sumatra, Indonesia*. <https://doi.org/10.4108/eai.19-7-2019.2289527>
- Siregar, P. S. (2023). Multiple Choice Question Difficulty Level Classification with Multi Class Confusion Matrix in the Online Question Bank of Education Gallery. *Journal of Applied Data Sciences*, 4(4), 392–406. <https://doi.org/10.47738/jads.v4i4.132>
- Sitohang, A. L., & Damanik, M. R. S. (2024). Difference in Geography Study Results of Students Taught by PBL (Problem Based Learning) and PjBL (Project Based Learning). *JPG (Jurnal Pendidikan Geografi)*, 11(2). <https://doi.org/10.20527/jpg.v11i2.19041>
- Supriatna, U., & Yunengsih, E. (2023). Pembelajaran Geografi Menggunakan Model Project Based Learning (PjBL) dalam Meningkatkan Minat Belajar Siswa Kelas XI di SMA Yumik Banjaran Kabupaten Bandung. *Geoarea*, 6, 2023. <https://ejournal.unibba.ac.id/index.php/>
- Syarif, E., Tabbu, M. A. S., Jamaluddin, A. Bin, & Saputro, A. (2024). Enhancing creative thinking and cultural literacy: Project-based learning with field trip support. *International Journal of Evaluation and Research in Education*, 13(6), 4017–4029.



<https://doi.org/10.11591/ijere.v13i6.30289>

- Torres-Peña, R. C., Peña-González, D., Chacuto-López, E., Ariza, E. A., & Vergara, D. (2024). Updating Calculus Teaching with AI: A Classroom Experience. *Education Sciences*, 14(9), 1019. <https://doi.org/10.3390/educsci14091019>
- Valente, T. W. (2025). Evidence for NI Effectiveness. In *Network Interventions* (pp. 74–91). Productivity Press. <https://doi.org/10.4324/9781003646754-5>
- Verma, K. (2017). Cultural Group Variances in Geospatial Thinking of Undergraduates in the United States: Educational Policy Implications. *Papers in Applied Geography*, 3(3–4), 406–423. <https://doi.org/10.1080/23754931.2017.1355841>
- Waluyaningtyas, A. D., Saryanto, & Rejokirono. (2025). Utilization of Artificial Intelligence in Strengthening the Pancasila Student Profile Project Integrated with STEM. *International Journal of Engineering, Science and Information Technology*, 5(1), 35–40. <https://doi.org/10.52088/ijesty.v5i1.625>
- Wang, J. (2015). Methods of the Study. In *Globalization of Leadership Development* (pp. 149–166). Springer Fachmedien Wiesbaden. https://doi.org/10.1007/978-3-658-06864-6_7
- Winiarti, S., Sunardi, Ahdiani, U., & Pranolo, A. (2022). Tradition Meets Modernity: Learning Traditional Building using Artificial Intelligence. *Asian Journal of University Education*, 18(2), 375–385. <https://doi.org/10.24191/ajue.v18i2.17992>
- Wiranto, A., Faipri Selegi, S., & Sukardi. (2021). Efektivitas Model Creative Problem Solving dan Project Based Learning terhadap Hasil Belajar IPS. *Jurnal Swarnabhumi*, 6(1). <https://doi.org/10.31851/yq98sa19>
- Wood, A. (2008). Conflict, power and politics in the city (1973): Kevin Cox. In P. Hubbard, R. Kitchin, G. Valentine (Eds.) *Conflict, power and politics in the city (1973): Kevin Cox* (pp. 33–42). SAGE Publications Ltd, <https://doi.org/10.4135/9781446213742.n5>
- Yanti, N., Arono, Hiasa, F., Junaidi, F., Noermanzah, & Kurniawan, R. (2025). Indonesian Teachers' Roles in Designing and Utilizing AI-Powered Animated Videos: A Case Study on Classroom Practices and Character Development. *International Journal of Learning, Teaching and Educational Research*, 24(6), 833–856. <https://doi.org/10.26803/ijlter.24.6.38>
- Yavich, R. (2025). Will the Use of AI Undermine Students Independent Thinking? *Education Sciences*, 15(6), 669. <https://doi.org/10.3390/educsci15060669>
- Yli-Panula, E., Jeronen, E., & Lemmetty, P. (2020). Teaching and learning methods in geography promoting sustainability. *Education Sciences*, 10(1), 5. <https://doi.org/10.3390/educsci10010005>
- Zaus, A. A., Giatman, M., Zaus, M. A., Zaus, A. A., & Islami, S. (2026). Enhancing Critical Thinking and Teamwork through AI-Integrated Project-Based Learning in Engineering Education. *JOIV: International Journal on Informatics Visualization*, 10(1), 94–104. <https://dx.doi.org/10.62527/joiv.10.1.3515>
- Zhong, Z., Hu, J., Tan, G., & Sun, C. (2009, March). The application of Google Earth in education. In *2009 first international workshop on education technology and computer science* (Vol. 1, pp. 10–13). IEEE. <https://doi.org/10.1109/ETCS.2009.10>

