

Impact of PBL, PJBL, and Learning Styles on Geography Achievement

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Abstract

This study aims to analyze the influence of Problem-Based Learning (PBL) and Project-Based Learning (PJBL) models, as well as learning styles (visual, auditory, and kinesthetic), on the geography learning outcomes of Grade X students at SMA Bhakti Mandala Nabire. The background of this research is grounded in the importance of geography instruction that adapts to the development of constructivist learning theories and the diversity of students' learning styles. This study employs a quantitative approach with a quasi-experimental design using a 3×2 factorial model. The sample consists of 30 students divided into two experimental groups based on the learning models and learning styles identified through the VAK questionnaire. Data were collected using pre-tests and post-tests and analyzed using two-way ANOVA. The results reveal that both the learning model and learning style significantly affect students' learning outcomes ($p < 0.05$). Furthermore, a significant interaction between learning models and learning styles was found in relation to geography learning outcomes. The PJBL model produced more stable outcomes across different learning styles, while PBL proved more effective for visual learners. Visual learners achieved the highest overall scores. These findings highlight the importance of differentiated instructional strategies that align with students' learning characteristics. The study provides both theoretical and practical contributions to the development of adaptive, student-centered geography curricula.

Keywords: Problem-Based Learning (PBL), Project-Based Learning (PJBL), Learning styles, Learning outcomes, and Geography

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1. Introduction

Education serves as a fundamental pillar in the development of a nation, and the quality of learning in schools plays a crucial role in shaping superior human resources. In the midst of globalization and rapid advancements in information technology, education is expected not only to transfer knowledge, but also to develop critical thinking, problem-solving abilities, and 21st-century life skills (Amin et al., 2020).

In this context, geography, as one of the subjects taught at the senior high school level, holds a strategic role in equipping students with an understanding of spatial dynamics and human–environment interactions at both local and global scales. Geography does not solely focus on spatial and locational aspects; it also encompasses a deeper understanding of geospheric processes, biodiversity, socio-economic dynamics, and the complex relationships between natural systems and human activities. Therefore, geography education needs to be designed with an approach that is not only conceptual but also contextual and applicable, in order to foster environmental awareness and the ability to think systemically and reflectively (Sajjadi et al., 2022).

In line with the development of learning theories, the Problem-Based Learning (PBL) and Project-Based Learning (PJBL) models have been widely implemented to enhance learning effectiveness. PBL emphasizes problem-solving through student inquiry and collaboration, with the teacher acting as a facilitator (Ambarwati & Amaluddin, 2019; Mukaromah et al., 2022). Meanwhile, PJBL allows students to learn by engaging in real-world, relevant projects that encourage them to integrate concepts and skills creatively (Ramadhan & Sya'ban, 2022; Rafik et al., 2022). Both models are considered effective in improving learning engagement, collaborative skills, and the real-life relevance of the material.

However, the effectiveness of these learning models cannot be separated from students' individual characteristics, particularly their learning styles. Learning styles—visual, auditory, and kinesthetic—represent students' unique preferences in processing and understanding information. Adapting learning strategies to these styles has the potential to enhance students' motivation, comfort, and academic achievement (Mutia et al., 2021; Astuti, 2023; Achmad et al., 2024). Unfortunately, research that integrates PBL and PJBL models with learning styles in the context of high school geography education remains limited.

Grade X students at SMA Bhakti Mandala Nabire were selected as the research subjects because they study foundational geography material that serves as a basis for understanding physical and social phenomena, making their learning outcomes crucial for evaluating the effectiveness of the applied learning methods. Furthermore, Grade X students are in the process of adapting to more complex learning models such as PBL and PJBL and possess diverse learning styles—visual, auditory, and kinesthetic—making this school an appropriate context for analyzing the interaction between learning models and learning styles. Easy access and the feasibility of systematic observation also support the selection of this research setting.

Therefore, this study aims to address this gap by analyzing the effects of PBL and PJBL models, along with students' learning styles, on geography learning outcomes among Grade X students at SMA Bhakti Mandala Nabire. By exploring the interaction between pedagogical approaches and students' learning preferences, this study is expected to contribute significantly to the development of more adaptive, inclusive, and

effective geography learning strategies that align with the demands of 21st-century education.

2. Method

This study employed a quantitative approach using a quasi-experimental design with a 3×2 factorial model. This design was selected to explore the effects of two independent variables—learning models (Problem-Based Learning and Project-Based Learning) and learning styles (visual, auditory, and kinesthetic)—on one dependent variable, namely the geography learning outcomes of tenth-grade students at SMA Bhakti Mandala Nabire. The factorial design enabled the researcher not only to examine the individual effects of each factor but also to evaluate the interaction between them. In this context, there were six treatment combinations comprising two learning models and three types of learning styles, each applied to student groups whose learning styles had been identified through a valid and reliable questionnaire.

The population of this study consisted of all tenth-grade students at SMA Bhakti Mandala Nabire, totaling 60 students. From this population, 30 students were purposively selected as the sample based on several criteria, namely equivalence in academic ability, engagement in learning, and learning motivation, ensuring a representative sample for evaluating the effectiveness of the learning models. The sample was divided into two experimental classes: one group was assigned to the Problem-Based Learning (PBL) treatment and the other to the Project-Based Learning (PJBL) treatment. Each treatment was subsequently combined with the students' identified learning styles (visual, auditory, and kinesthetic), resulting in six experimental treatment groups.

Data were collected using two main instruments: a learning outcome test and a learning style questionnaire. The test used in this study consisted of pre-test and post-test items in the form of multiple-choice and essay questions, designed to assess students' understanding of geographical concepts, analytical thinking skills, the ability to apply the material in relevant contexts, as well as their scientific communication skills in presenting answers logically, systematically, and based on relevant evidence. The pre-test was administered to ensure initial homogeneity across groups, while the post-test was used to evaluate the impact of the learning treatments. Meanwhile, the learning style questionnaire was developed based on the VAK (Visual, Auditory, Kinesthetic) theory and comprised a series of statements reflecting students' learning preferences. This questionnaire had undergone content validity testing and reliability analysis using Cronbach's Alpha to ensure data accuracy.

The data obtained were analyzed using both descriptive and inferential statistical methods. The primary analysis employed was Two-Way ANOVA to examine the effects of each independent variable and the interaction between learning models and learning styles on learning outcomes. Prior to conducting the ANOVA, assumptions of normality (using the Kolmogorov-Smirnov test) and homogeneity (using Levene's test) were tested. If these assumptions were met, the analysis proceeded with ANOVA to test three main hypotheses: (1) whether there are differences in learning outcomes based on the learning model, (2) whether there are differences in learning outcomes based on learning style, and (3) whether there is a significant interaction between the learning model and learning style on students' geography learning outcomes. All analyses were conducted using the SPSS statistical software to ensure precision in calculations and interpretation of results.

Through this methodological approach, the study aims to provide empirical contributions to the development of more effective and adaptive geography learning strategies that align with students' learning styles and improve academic achievement at the secondary education level.

3. Result and Discussion

This study aims to examine the influence of Problem-Based Learning (PBL) and Project-Based Learning (PJBL) models, as well as learning styles, on the geography learning outcomes of Grade X students at SMA Bhakti Mandala Nabire. The analysis employs both descriptive and inferential approaches, beginning with instrument validity and reliability tests, followed by a two-way ANOVA analysis.

A. Descriptive Results of the Post-Test

The students' learning outcome data were collected through a post-test administered after they had undergone instruction using the PBL and PJBL models. The data were then classified based on visual, auditory, and kinesthetic learning styles. The complete results are presented in Table 1 below:

Table 1. Descriptive Statistics of Students' Learning Outcomes by Instructional Models and Learning Styles

Learning Model	Learning Style	Mean	Std. Deviation	Number of Students
PBL	Visual	93.00	2.075	14
	Auditory	83.57	1.134	7
	Kinesthetic	84.33	1.000	9
	Total	88.20	4.838	30
PJBL	Visual	90.85	2.035	13
	Auditory	87.00	1.789	6
	Kinesthetic	86.55	1.572	11
	Total	88.50	2.739	30
Total	Visual	91.96	2.295	27
	Auditory	85.15	2.267	13
	Kinesthetic	85.55	1.731	20
	Total	88.35	3.901	60

The results show that students with a visual learning style achieved the highest average learning outcomes, both in the PBL group (93.00) and the PJBL group (90.85). Overall, the PJBL model demonstrated more consistent results across different learning styles, whereas the PBL model showed greater variation among learning styles

B. Test of Normality and Homogeneity Assumptions

Before conducting the two-way ANOVA analysis, assumption testing was carried out, including tests for homogeneity and normality, to ensure that the data met the criteria for parametric statistical analysis. The homogeneity test using Levene's Test showed a significance value of 0.761 ($p > 0.05$). This value indicates that the variances among the groups are homogeneous or relatively equal in distribution, thus fulfilling the requirements for further analysis.

Next, normality testing was conducted using two approaches: the Kolmogorov-Smirnov test and the Shapiro-Wilk test. The results of both tests showed that the significance values for all groups were greater than 0.05. Therefore, it can be concluded that the students' learning outcome data are normally distributed. These two tests confirm that the data are suitable for analysis using the two-way ANOVA technique.

C. Outcomes of the Two-Way ANOVA Test

A two-way ANOVA was employed to examine the individual and interaction effects of the factors on students' learning outcomes. The findings are shown in Table 2.

Table 2. Findings of the Two-Way ANOVA Analysis

Tests of Between-Subjects Effects					
Dependent Variable: Learning Outcome					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	735.516 ^a	5	147.103	48.994	.000
Intercept	418151.374	1	418151.374	139268.709	.000
Model	18.424	1	18.424	6.136	.016
Gaya	633.304	2	316.652	105.463	.000
Model * Gaya	89.693	2	44.847	14.937	.000
Error	162.134	54	3.002		
Total	469241.000	60			
Corrected Total	897.650	59			

a. R Squared = .819 (Adjusted R Squared = .803)

The results of the two-way ANOVA analysis indicate that the learning model has a significant effect on students' geography learning outcomes, with a significance value of 0.016 ($p < 0.05$). This suggests that the use of Problem-Based Learning (PBL) and Project-Based Learning (PJBL) models leads to meaningful differences in students' academic achievement. Furthermore, learning styles also have a significant influence on learning outcomes, with a significance value of 0.000 ($p < 0.05$). Students with a visual learning style consistently demonstrated higher achievement compared to those with auditory or kinesthetic learning styles.

In addition, the analysis results show a significant interaction between learning models and learning styles on students' learning outcomes, with a significance value of 0.000 ($p < 0.05$). This finding confirms that the effectiveness of a learning model depends on its compatibility with students' learning style characteristics. Therefore, selecting an appropriate learning model should consider students' learning style preferences to optimize academic performance.

These findings indicate that the choice of learning model cannot be separated from an understanding of students' learning characteristics. Visual learners tend to excel in geography due to the alignment between visual materials such as maps and graphs and their learning preferences. The PJBL model offers consistent performance across different learning styles, while the PBL model yields greater impact particularly for visual learners. Thus, the development of differentiated instruction strategies and the mapping of learning styles are highly recommended to enhance the quality of geography learning outcomes.

D. The Influence of Learning Models on Learning Outcomes

The research findings indicate that the learning model has a significant effect on students' geography learning outcomes, with a significance value of 0.016 ($p < 0.05$). This difference confirms that constructivist-based learning approaches—whether through Problem-Based Learning (PBL) or Project-Based Learning (PJBL)—are capable of meaningfully enhancing students' understanding compared to conventional approaches. Practically, the PJBL model contributes more positively in terms of consistency across different learning styles. The average learning outcome score in the PJBL group (88.50) was slightly higher than that in the PBL group (88.20), with a smaller standard deviation. This suggests that PJBL is more adaptive in addressing diverse learning styles, especially in the context of geography learning, which is inherently visual, spatial, and contextual. Meanwhile, the PBL model is more effective in fostering higher-order thinking skills (HOTS) and proves highly beneficial for students with a visual learning style preference.

This study supports the findings of Arisanty (2020), who stated that PJBL provides meaningful learning opportunities through active student engagement in real-world projects. Similarly, Alnursa (2018) emphasized that PBL enhances critical thinking and problem-solving skills. Silviarza et al. (2020) also demonstrated that Spatial PBL is highly effective in geography education due to its ability to develop spatial analysis skills. In addition, Lestari & Lubis (2023) noted that PJBL improves critical thinking skills through the use of visual media in instruction, which aligns well with the nature of geography. This is further reinforced by Husna et al. (2024), who highlighted that PJBL requires students to produce real, contextually relevant products, making it especially advantageous for learners with a visual learning style.

E. The Influence of Learning Styles on Learning Outcomes

Statistical analysis reveals that learning styles have a significant effect on geography learning outcomes ($p = 0.000$), with students who prefer visual learning consistently achieving the highest scores (mean = 91.96). This finding is unsurprising, considering that geography naturally involves visual content such as maps, diagrams, satellite imagery, and spatial graphs. Visual learners tend to process information more effectively through images and spatial symbols, which enables them to better understand geographic concepts and the relationships between phenomena.

Students with auditory and kinesthetic learning styles scored relatively lower (85.15 and 85.55, respectively), although their performance still falls within a good achievement category. Nevertheless, these results indicate the need for varied and adaptive teaching strategies that align with the learning preferences of non-visual learners. Within the framework of student-centered learning, teachers are required not only to understand the nature of the subject matter but also to identify the dominant learning styles of students as a foundation for designing responsive and inclusive learning processes.

These findings are consistent with the study by Banggo (2023), which emphasizes that visual learners excel in understanding spatial representations in geography. Jamal et al. (2023) further suggest that visual learning styles offer cognitive advantages in conceptual and visual subjects such as geography. However, research by Nargis et al. (2021) indicates that auditory learning can also be enhanced through engaging audio-based content delivery. Another study by Mudanta et al. (2020) links learning outcomes to student motivation, which may vary according to learning style. Collectively, these findings underscore the importance of implementing adaptive and responsive teaching

approaches that cater to diverse student learning styles.

F. The Interaction between Learning Models and Learning Styles on Learning Outcomes.

The most substantial finding of this study is the significant interaction between instructional models and learning styles on students' geography learning outcomes ($p = 0.000$). This result indicates that the effectiveness of a teaching model is not universal; rather, it is highly influenced by the alignment between the instructional approach and the individual learner's characteristics. For instance, visual learners demonstrated the highest performance under the Problem-Based Learning (PBL) model, which requires them to organize information using diagrams, mind maps, and schematics. In contrast, kinesthetic learners performed better under the Project-Based Learning (PJBL) model, which allows them to move, interact directly with real objects or environments, and engage in hands-on project activities.

This concept aligns with the principles of differentiated instruction, which emphasize the importance of flexibility in teaching approaches to accommodate students' diverse learning styles and needs. The significant interaction between teaching models and learning styles highlights that there is no single best instructional approach; rather, the most effective strategy is one that is tailored to students' learning profiles. Therefore, the integration of instructional model selection and learning style mapping becomes essential in optimizing geography learning outcomes.

For example, visual learners excelled in PBL, which enables them to visualize ideas through maps and diagrams, whereas kinesthetic learners performed better in PJBL, which emphasizes direct, practical engagement. This finding is consistent with research by Sitorus et al. (2023), which stresses the importance of flexible and engaging teaching styles to address the variety of student learning preferences. Furthermore, research by Tampubolon et al. (2024) underlines that optimal learning outcomes are achieved when instructional strategies are aligned with students' learning styles and self-efficacy.

G. Pedagogical and Theoretical Implications

The findings of this study have significant implications for instructional practices in secondary schools. First, teachers need to systematically map students' learning styles in order to align the instructional models they employ. Second, flexibility in curriculum implementation is essential, allowing teachers the space to innovate based on the unique characteristics of their classrooms. Third, the results highlight the urgency of teacher training in differentiated instruction strategies and the integration of educational technologies that support diverse learning needs.

Theoretically, these findings confirm the concepts of instructional alignment and learner-centered teaching, while also expanding our understanding of the critical interaction between instructional methods and students' cognitive preferences. This study also lays a foundation for developing a geography learning framework based on personalized learning—one that not only considers content and learning objectives but also acknowledges the characteristics and potential of individual learners.



Figure 1. PJBL research



Figure 2. PBL research

4. Conclusion

The Based on the results of the research conducted, it can be concluded that both learning models and learning styles have a significant influence on the geography learning outcomes of Grade X students at SMA Bhakti Mandala Nabire.

First, the use of Problem-Based Learning (PBL) and Project-Based Learning (PJBL) models demonstrably has a positive impact on improving students' learning outcomes. While both models are effective, PJBL demonstrates superiority in terms of consistency across different learning styles, whereas PBL proves to be more optimal for students with a visual learning style.

Second, students' learning styles play an essential role in determining academic achievement. Students with a visual learning style achieved the highest learning outcomes compared to those with auditory and kinesthetic styles. This indicates that learning approaches that incorporate visual elements can significantly enhance students' understanding and mastery of geography content.

Third, there is a significant interaction between learning models and learning styles in influencing student learning outcomes. This means the effectiveness of a learning model strongly depends on its alignment with students' learning styles. The application of adaptive, learning-style-based instructional models has been proven to optimize individual learning achievement.

Overall, these findings underscore the importance of differentiated and student-centered instructional strategies. Teachers need to understand the learning characteristics of their students and select appropriate instructional models to ensure that the geography

learning process becomes more meaningful, inclusive, and effective. This research provides both practical and theoretical contributions to educational policy formulation and curriculum development that are responsive to the needs and diversity of learners.

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