Effectiveness of Google Sites–Assisted Problem-Based Learning on High School Students' Analytical Skills in Lithosphere Learning

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Abstract: This study examined the effectiveness of Problem-Based Learning (PBL) assisted by Google Sites in improving students' analytical thinking in lithosphere topics. A quasi-experimental nonequivalent control group design involved 68 tenth-grade students, divided into an experimental (PBL and Google Sites) and a control (conventional instruction) group. Analytical skills were measured with a validated essay test targeting the indicators of differentiating, organizing, and attributing. Data were analyzed with the Mann–Whitney U test due to non-normality. Results showed a significant difference ($p < 0.05$), with the experimental group achieving higher mean scores and a large effect size ($r = 0.79$). The findings indicate that integrating PBL with a web platform effectively enhances analytical competence in geography learning. Practical implications suggest that teachers can use Google Sites to structure problem scenarios, learning tasks, worksheets, and assessments. Limitations include single-school sampling and short treatment duration; future research should apply N-gain analysis, test other topics, and compare platforms.

Abstrak: Penelitian ini mengkaji efektivitas Problem-Based Learning (PBL) berbantuan Google Sites dalam meningkatkan kemampuan berpikir analitis siswa pada materi litosfer. Penelitian kuasi-eksperimental dengan desain nonequivalent control group melibatkan 68 siswa kelas X yang dibagi menjadi kelompok eksperimen (PBL dan Google Sites) dan kontrol (pembelajaran konvensional). Instrumen berupa tes esai tervalidasi yang mengukur indikator membedakan, mengorganisasi, dan mengatribusikan; data dianalisis menggunakan uji Mann–Whitney. Hasil menunjukkan perbedaan signifikan ($p < 0,05$) dan kelompok eksperimen memperoleh skor rata-rata lebih tinggi dengan ukuran efek besar ($r = 0,79$). Temuan ini mengonfirmasi bahwa integrasi PBL dan Google Sites efektif dalam meningkatkan kemampuan analitis pada pembelajaran geografi litosfer. Implikasi praktisnya adalah guru dapat memanfaatkan platform web sederhana untuk menyusun skenario masalah, LKPD, dan penilaian yang mendukung pembelajaran berbasis inkuiri. Keterbatasan meliputi cakupan sampel tunggal dan durasi perlakuan singkat; penelitian lanjutan dianjurkan menerapkan N-gain, materi lain, dan perbandingan platform. Hasil relevan bagi pengembangan praktik pembelajaran digital sekolah.

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A. Introduction

Each learning model has distinct characteristics designed to accommodate students' needs, interests, and learning potential. By understanding and implementing appropriate learning models, teachers can develop instructional strategies that promote deeper conceptual understanding and improve student Engagement in the learning process (Nafi'ah et al., 2025; Nurdyansyah & Fahyuni, 2016; Khoerunnisa & Aqwal, 2020). In contemporary education, learning models are expected not only to deliver content knowledge but also to foster higher-order thinking skills that enable students to analyze, interpret, and evaluate information critically. Such competencies are increasingly important in subjects that involve complex systems and interrelated phenomena, including geography. However, despite the importance of developing higher-level cognitive skills, geography learning at the high school level is still frequently dominated by memorization and factual knowledge. Many students perceive geography as monotonous and overly reliant on rote learning, limiting their opportunities to engage in analytical reasoning and conceptual exploration (Yanmesli, 2018). Consequently, students often focus on recalling information rather than developing a deeper understanding of geographical processes and relationships.

This issue becomes particularly evident in complex topics such as the lithosphere. The lithosphere material requires students to understand geological processes, tectonic plate interactions, and environmental impacts systematically (Larasaty, 2024). Understanding these concepts involves more than recalling definitions; students must also analyze relationships among geological events, interpret tectonic movements, and explain the causal mechanisms underlying various geological phenomena. Such tasks demand analytical thinking skills that enable students to differentiate among concepts, organize information logically, and interpret cause–and–effect relationships within natural systems. In practice, however, many students struggle to learn lithosphere concepts. They often struggle to differentiate key ideas, organize relationships between geological processes, and interpret the mechanisms behind tectonic phenomena. As a result, their analytical abilities remain underdeveloped, which, in turn, affects their overall understanding of geographic systems. According to Novita et al (2016), students with weak analytical abilities tend to encounter difficulties when connecting concepts and interpreting phenomena meaningfully. These analytical skills are particularly essential in geography because the discipline emphasizes the interconnectedness of natural processes and the interpretation of complex environmental interactions.

To address this issue, the implementation of innovative learning models that encourage active student Engagement becomes necessary. One instructional approach that has gained considerable attention in educational research is Problem-Based Learning (PBL). PBL is a student-centered learning model that engages learners in solving contextual and authentic problems through structured inquiry, collaboration, and reflection (Nafi'ah et al., 2025; Syafi'aturrosyidah et al., 2022). Through investigating problems, discussing possible solutions, and evaluating evidence, students actively construct knowledge rather than passively receiving information from teachers. This learning process encourages students to

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develop reasoning, analytical thinking, and problem-solving skills that are essential for understanding complex academic content. Previous studies have shown that PBL can significantly improve students' critical and analytical thinking skills by providing opportunities to analyze problems, identify relevant information, and propose evidence-based explanations (Dulyapit et al., 2023). In geography education, the use of contextual problems can help students relate theoretical concepts to real-world environmental phenomena, thereby strengthening their conceptual understanding.

Nevertheless, effective implementation of PBL requires well-structured learning support that helps organize instructional materials, problem scenarios, and student activities. Without proper organization, students may struggle to navigate learning tasks or connect the different stages of the problem-solving process. In the digital era, integrating educational technology can play an important role in supporting the implementation of student-centered learning models, such as PBL (Fitria & Indra, 2021). Technology-based platforms can facilitate access to learning resources, organize instructional content systematically, and support collaborative learning activities. One technological tool that can support this purpose is Google Sites. Google Sites is a web-based platform that allows teachers to design and manage instructional materials, learning tasks, and assessments in a structured digital environment (Kusumaningtyas, 2022; Napitu, 2023). Through Google Sites, teachers can provide problem scenarios, supporting materials, and instructional guidance in an organized, easily accessible format for students. Previous studies have shown that the use of digital learning platforms can increase student Engagement and motivation in the learning process (Yusron, 2023; Pradana et al., 2024). Therefore, integrating PBL with Google Sites has the potential to create a structured digital learning environment that facilitates inquiry-based learning and supports the development of students' analytical skills.

Despite the increasing interest in Problem-Based Learning and digital learning media, several limitations remain in existing studies. First, many previous studies have examined the effectiveness of PBL in improving learning outcomes. However, they often implement the model without integrating structured digital learning platforms that support the organization of learning materials and activities. Second, research on the use of Google Sites as an instructional medium has not been widely explored in geography learning, particularly in topics related to the lithosphere. Most studies on digital learning tools focus on other subjects or use different types of technological platforms. Third, previous research rarely measures analytical skills with specific, clearly defined indicators. In many studies, analytical thinking is assessed broadly without distinguishing its key components, such as differentiating, organizing, and attributing information. The absence of explicit measurement indicators may limit the precision with which researchers can evaluate the development of students' analytical skills. These limitations indicate a research gap concerning the integration of PBL and Google Sites with explicit measurement of analytical skills in the context of lithosphere learning.

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To address this gap, the present study introduces an integrated instructional approach that combines Problem-Based Learning with Google Sites as a structured digital learning environment. The novelty of this research lies in two main aspects. First, this study integrates the PBL model with Google Sites to create a digital platform that systematically organizes problem scenarios, learning materials, and student activities. This integration is expected to support the effective implementation of inquiry-based learning and enhance students' Engagement with complex geographical concepts. Second, this study measures students' analytical skills using three specific indicators: differentiating, organizing, and attributing, which represent essential components of analytical thinking (Blegur et al., 2023). By applying these indicators, the study provides a more detailed evaluation of how instructional strategies influence the development of analytical reasoning. Furthermore, this research applies the integrated approach specifically to the lithosphere in high school geography instruction, thereby providing empirical evidence on the effectiveness of technology-assisted PBL in enhancing students' analytical skills.

Based on the identified research gap and the proposed novelty, this study aims to examine the effectiveness of Google Sites–assisted Problem-Based Learning in improving students' analytical skills in lithosphere learning. Specifically, this research investigates whether integrating PBL with Google Sites can enhance students' ability to differentiate concepts, organize relationships among geological processes, and attribute causal mechanisms underlying lithosphere phenomena. Therefore, the research question addressed in this study is whether there is a significant difference in analytical skills between students taught using Google Sites–assisted Problem-Based Learning and those taught using conventional learning. Accordingly, this study hypothesizes that students who learn through Google Sites–assisted Problem-Based Learning demonstrate higher analytical skills than students who receive conventional instruction.

B. Method

This study employed a quasi-experimental design with a nonequivalent control group. This design was selected because the participants were drawn from intact classes formed by the school, making random assignment at the individual level impractical. According to Arib et al (2024), experimental studies deliberately introduce a particular condition to observe its impact. Thus, this method is suitable for determining correlations between two variables. The research adopted a Nonequivalent Control Group Design, involving two pre-existing classes (Nofziarni et al., 2019). The research design flow is presented in Figure 1.

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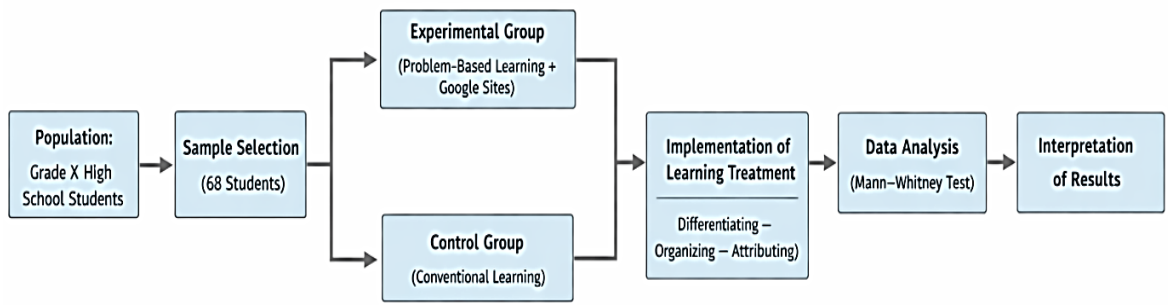

Figure 1. Research Flow

The participants were Grade X students at a public senior high school. Because the classes had already been administratively formed, cluster random sampling was used to select two intact classes as research samples. One class was assigned to the experimental group, and the other to the control group. The study compared students' analytical skills between an experimental group that received Google Sites–assisted Problem-Based Learning and a control group that received conventional instruction. The experiment consisted of two groups: one experimental and one control. The experimental group (Class X-1) was taught using the PBL model assisted by Google Sites, while the control group (Class X-2) received conventional instruction. This approach is appropriate for quasi-experimental research conducted in natural classroom settings.

Students' analytical skills were measured using an essay-based test developed according to three analytical indicators: differentiating, organizing, and attributing (Blegur et al., 2023; Astriani et al., 2018). These indicators represent essential components of analytical thinking, including distinguishing relevant information, structuring relationships among concepts, and interpreting phenomena logically (Muhaimin, 2019).

The instrument was constructed based on a detailed test blueprint to ensure alignment with learning objectives and analytical indicators. Content validity was established through expert judgment by geography education experts. Item validity was examined using product-moment correlation, and items that did not meet validity criteria were revised. Reliability testing was conducted using Cronbach's Alpha, and the instrument demonstrated acceptable reliability for research use.

The study was conducted during the lithosphere learning unit over several meetings. In the experimental group, instruction followed the stages of Problem-Based Learning: problem orientation, investigation, analysis, and solution presentation (Anggiana, 2019). Google Sites was utilized to organize problem scenarios, learning materials, worksheets, and assessments in a structured digital format. The integration of digital platforms supports interactive and organized learning processes (Kusumaningtyas, 2022; Yusron, 2023). The assessment was conducted in person using a Google Form integrated into the learning site, facilitating automatic scoring and data collection (Furqan et al., 2023). The experimental class used the PBL model assisted by Google Sites, while the control class experienced traditional instruction. A supervising teacher validated the post-test questions to ensure content appropriateness and depth. Each question assessed analytical ability through three

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indicators—differentiation, organization, and attribution—measuring not only memorization but also conceptual application and reasoning. Meanwhile, the control group received conventional instruction consisting of teacher explanations, guided discussions, and textbook-based exercises.

Descriptive statistics were used to compare post-test mean scores between groups. Prior to hypothesis testing, data normality was assessed using the Shapiro–Wilk test because the number of data analyzed was less than 50. Homogeneity using Levene's test. If both groups met the normality assumptions, an independent-samples t-test was employed. However, if one or both groups did not meet normality criteria, the Mann–Whitney U test was used as a non-parametric alternative. The significance level was set at 0.05. Effect size analysis was also conducted to determine the magnitude of the treatment effect.

C. Result

Google Sites served as an integrated digital medium for delivering instructional materials. Within the site, the researcher embedded PowerPoint presentations (PPT) as teaching aids that visually and effectively conveyed key concepts. In addition, Student Worksheets (LKPD) were provided in interactive PDF or Google Form formats, allowing students to access and complete them online. A post-test was administered on November 19, 2024, to both groups—Class X-1 (experimental) and Class X-2 (control).

The entire post-test measures students' analytical skills in the lithosphere through three main indicators: differentiating, organizing, and attributing (interpreting). Data analysis in this study began with descriptive statistics, testing of statistical assumptions, hypothesis testing, and effect size estimation. This testing was conducted using IBM SPSS (Statistical Package for the Social Sciences) version 26.

Descriptive Statistics

Descriptive statistics were calculated to compare students' analytical skills between the experimental and control groups. The results show that the experimental group achieved a higher post-test mean score compared to the control group.

The experimental group demonstrated substantially higher post-test scores compared to the control group. This indicates an initial tendency that students who received Google Sites–assisted Problem-Based Learning achieved better analytical performance.

Assumption Testing

Before conducting hypothesis testing, the normality of students' post-test analytical skills scores was assessed to determine the appropriate statistical test.

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Normality Test

Table 1. Normality Test

	Class	P
Analytical Skills	Experiment	,000
	Control	,219

Based on Table 1, the results of the normality test for the experimental class show a significance value of 0.000 (<0.05), indicating that the experimental class data is not normally distributed. Meanwhile, in the control class, the significance value is 0.219 (<0.05), indicating that the data are not normally distributed.

Homogeneity Test

The homogeneity test aims to compare variations within a research population to ensure that the analyzed data originate from a population with nearly the same diversity. This homogeneity test uses Levene's Test, which examines whether the variances of the two groups come from the same population.

Table 2. Homogeneity Test

	P
Analytical Skills	,713

Based on Table 2, the results of the homogeneity test for the study indicate that the use of the Google Sites-assisted PBL model on the Post-Test data from the experimental and control classes has a Levene's Test p-value above 0.05. A significance of 0.713 (>0.05) indicates that the data is homogeneously distributed and there is no significant difference in variance between the two groups. This indicates that the variance of the Post-Test results across both groups meets the requirements for non-parametric testing, which was employed for hypothesis testing, such as the Mann–Whitney U test.

Hypothesis Testing

Since the normality assumptions were not fully met, the Mann–Whitney U test was used to examine group differences.

Table 3. Mann–Whitney U test

	U	*Z*	*p-Value*
Analytical Skills	51,00	-6,560	,000

Based on Table 3, the results revealed a statistically significant difference between the experimental and control groups. The result shows that $p < 0.05$, indicating a statistically

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significant difference in analytical skills between the experimental and control groups. Thus, the null hypothesis is rejected.

Effect Size

The effect size was calculated using the r formula for non-parametric testing. Below, I have attached the formula for calculating the effect size using the r formula.

$$r = \frac{Z}{\sqrt{N}}$$

Based on the formula, Z is the standard test statistic from the Mann–Whitney U test, and N is the total number of participants. The absolute value of Z was used in the calculation. According to Cohen's criteria (Cohen et al., 2018), an effect size of 0.10 is considered small, 0.30 moderate, and 0.50 large. Therefore, the obtained effect size (r = 0.79) indicates a large effect, suggesting that Google Sites–assisted Problem-Based Learning had a substantial impact on students' analytical skills. This finding confirms that Google Sites–assisted Problem-Based Learning had a substantial impact on improving students' analytical skills compared to conventional learning.

D. Discussion

The research shows that implementing the PBL model supported by Google Sites yields significant improvements in students' analytical skills for the lithosphere material. This study aimed to examine whether there was a significant difference in analytical skills between students taught using Google Sites–assisted Problem-Based Learning and those taught using conventional instruction. The results clearly indicate a statistically significant difference ($U = 51.00$, $Z = -6.560$, $p < 0.05$), with a large effect size ($r = 0.79$). Therefore, the research hypothesis is accepted. Students who learned through Google Sites–assisted PBL demonstrated significantly higher analytical skills than those who received conventional instruction.

The superiority of the experimental group can be explained through the learning mechanism implemented. Problem-Based learning requires students to engage in contextual problem-solving processes, including identifying relevant information, analyzing relationships, and constructing reasoned conclusions (Dulyapit et al., 2023). Unlike conventional instruction, which is often teacher-centered and focused on information delivery, PBL positions students as active investigators. This structured inquiry process stimulates deeper cognitive Engagement and analytical reasoning. These results align with previous studies by Sentosa & Norsandi (2022), who found that PBL was effective in improving students' analytical skills in geography through problem-solving. Yusron (2023) reported that digital tools such as Google Sites enhance students' motivation and autonomy.

The integration of Google Sites further strengthened this mechanism. Google Sites provided structured access to problem scenarios, multimedia learning materials, and organized worksheets. Such digital structuring supports systematic exploration and independent learning (Kusumaningtiyas, 2022) and increases Engagement and learning

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motivation (Yusron, 2023). The combination of structured inquiry (PBL) and structured digital organization (Google Sites) appears to have created an optimal environment for the development of analytical skills.

The application of the Google Sites-assisted PBL model to the lithosphere topic has been shown to improve students' analytical skills. Through five stages of structured syntax, this model encourages active involvement and critical thinking in understanding geological phenomena. In the problem-orientation stage, teachers present contextual problems on Google Sites through text, images, and videos, helping students understand the context thoroughly and fostering motivation to find solutions independently. The learning organization stage is carried out by forming small groups so that students can collaborate to identify prior knowledge and formulate information search strategies. With teacher guidance and Google Sites, students learn to select relevant information and organize concepts systematically. Next, in the investigation stage, students conduct an in-depth exploration to discover the relationship between the lithosphere and geological phenomena such as plate movement, subduction, and mountain formation. This learning process trains students' analytical and scientific reasoning skills. In the development and presentation stage, students are asked to create a digital report or presentation based on their analysis, then present it to the class. This activity also trains scientific communication skills (Merli, 2021), reflective thinking skills, and strengthens conceptual understanding through feedback from teachers and peers. The final stage, evaluation and reflection, serves to review students' thought processes and deepen their understanding of the material they have learned. Therefore, implementing the PBL model, supported by Google Sites, can improve conceptual understanding of the lithosphere and develop critical, analytical, and reflective thinking skills, which are essential for 21st-century learning.

The structured five-phase PBL syntax used in this study—problem orientation, task organization, independent inquiry, product presentation, and reflection—proved effective in nurturing critical, analytical, and reflective thinking. Google Sites enriched these stages by providing interactive visuals, discussions, and online assessments that fostered Engagement. In line with Darwati & Purana (2021), these findings confirm that PBL, when integrated with digital media, produces organized, interactive, and meaningful learning experiences. In addition, research by Darkay et al (2025) indicates that the PBL model comprises five stages of syntax: problem orientation, organization of learning tasks, independent investigation, development and presentation of results, and analysis and evaluation of the problem-solving process. Therefore, the results of this study are supported conceptually and empirically by the two reference journals as an effective learning model in the context of modern learning.

The findings of this study are consistent with previous research indicating that PBL enhances higher-order thinking skills. Dewi et al (2019) reported that PBL improves analytical and problem-solving abilities by promoting active knowledge construction. Similarly, Dulyapit et al (2023) found that structured problem-solving stages significantly enhance students' cognitive Engagement. The present study extends these findings by

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integrating a digital learning platform into the PBL framework, demonstrating that technology-assisted PBL can produce a substantial effect size in geography learning contexts.

However, it is also important to consider factors that may explain performance differences between groups. The control class received conventional instruction, which may have limited opportunities for independent inquiry and structured problem-solving. Additionally, external factors such as students' digital readiness, familiarity with online platforms, and access to stable internet connections may have influenced learning experiences in the experimental group. Although these factors were not directly measured, they could contribute to variations in learning outcomes and should be considered in future research. From a pedagogical perspective, the results imply that integrating student-centered learning models with structured digital platforms can effectively support the development of analytical skills in geography education. Given that geography emphasizes interconnected natural phenomena, instructional approaches that promote systematic analysis and contextual reasoning are essential for fostering higher-order thinking skills. Therefore, Google Sites–assisted PBL can be considered a viable instructional strategy for enhancing analytical competence in lithosphere learning and potentially other complex geography topics.

E. Implication

This study provides empirical support for integrating Problem-Based Learning (PBL) with structured digital platforms to enhance analytical thinking as part of higher-order thinking skills (HOTS). The significant difference and large effect size ($r = 0.79$) indicate that digital-assisted PBL strengthens students' abilities to differentiate, organize, and attribute concepts systematically in geography learning. In practice, geography teachers can use Google Sites to structure Problem-Based Learning activities, including organizing LKPD, presenting problem scenarios, integrating multimedia materials, and administering post-tests. This structured digital support facilitates more systematic and inquiry-based learning, particularly for complex topics such as the lithosphere. At the institutional level, schools should strengthen internet infrastructure and support teachers in using simple web-based learning platforms. Providing digital training and encouraging technology-integrated pedagogy can enhance the implementation of student-centered learning models and support the development of analytical skills.

F. Limitation and Suggestion for Further Research

This study has several limitations. First, the analysis focused on post-test differences and did not examine normalized gain (N-gain) from post-test scores to more precisely measure learning improvement. Second, the treatment duration was relatively short and limited to one lithosphere unit, which may not fully capture long-term learning effects. Third, the study involved only one school, limiting the generalizability of the findings.

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Additionally, variations in internet connectivity and students' digital readiness may have influenced the implementation of Google Sites–assisted learning.

Future research is recommended to apply a post-test design with N-gain analysis to obtain a more accurate measurement of learning improvement. Studies may also test the effectiveness of digital-assisted PBL on other geography topics, such as the hydrosphere and atmosphere, to examine consistency across materials. Comparative studies between Google Sites and other learning management systems (e.g., Moodle or Google Classroom) are suggested to identify the most effective digital platform. Finally, longitudinal research is needed to examine the long-term retention effects of analytical skill development.

G. Conclusion

This value indicates that the experimental group, using the PBL learning model with Google Sites, experienced a very significant increase in analytical skills compared to the control group. The results of the Mann–Whitney U test show a significant difference in analytical skills between students taught through Google Sites–assisted Problem-Based Learning and those taught through conventional learning, with a large effect size (r = 0.79). These findings indicate that integrating PBL with Google Sites effectively enhances students' analytical skills in lithosphere learning. Thus, the research objective is achieved, confirming that digital-assisted PBL leads to higher analytical performance compared to conventional instruction. It is recommended that geography teachers implement structured digital platforms to support inquiry-based learning and strengthen higher-order thinking skills.

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