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Improving Learning Engagement and Performance through Google Sites-Based Project Learning in Vocational Network Education

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Abstract: The advancement of web-based technology has opened new opportunities for enhancing the quality of teaching and learning in vocational education. This study aims to examine the effectiveness of Google Sites as a digital learning media combined with the Project-Based Learning (PjBL) model in improving student learning outcomes in the subject of Network System Administration. Conducted using Classroom Action Research (CAR) in two cycles, this study involved 31 students from class XI TKJ at SMKN 5 Padang. Data were collected through observation, documentation, and learning achievement tests. The findings show a consistent increase in students' learning engagement and performance. The average learning outcomes rose from 67.42 (pre-cycle) to 78.86 (cycle II), with student mastery increasing from 68% to 90%. The integration of Google Sites facilitated independent and flexible access to learning materials, while the PjBL model encouraged collaborative problem-solving and practical skill development. These results suggest that the combination of interactive digital media and project-based instruction significantly enhances the effectiveness of vocational learning environments.

Keywords: Google Sites; Project-Based Learning; Learning Outcomes; Vocational Education; Digital Media.

1. Introduction

The emergence of digital technologies has transformed the educational landscape across the globe [1]–[3]. In the 21st century, digital competence and technological literacy are considered core skills that educational systems must foster in students to prepare them for dynamic, digitally-driven work environments. In response, schools are increasingly challenged to integrate digital tools and online platforms into teaching and learning processes. This is especially relevant in vocational education and training (VET), which must align closely with industry needs and technological advancements to ensure students are job-ready upon graduation [4], [5].

Despite this global shift, the implementation of technology-enhanced learning in vocational schools—particularly in developing countries such as Indonesia—remains inconsistent. Many schools are equipped with internet infrastructure, yet still rely heavily on traditional face-to-face instruction with minimal use of digital media. This technological underutilization often results in a lack of student engagement, superficial understanding of technical subjects, and low academic performance [6]–[11]. In particular, subjects like Network System Administration require not only conceptual understanding but also practical, hands-on experience in configuring and managing network systems. Without engaging instructional approaches, students frequently struggle to grasp abstract topics such as routing protocols, IP addressing, and system configuration.

Recent research suggests that the combination of interactive web-based learning platforms and constructivist learning models—such as Project-Based Learning (PjBL)—can significantly improve student motivation and learning outcomes in technical subjects [12]–[15]. PjBL is a student-centered approach that encourages learners to construct knowledge through real-world problem solving and collaborative projects. When supported by well-designed digital media, PjBL can create a dynamic learning environment where students become active participants rather than passive recipients of knowledge [16]–[18].

Among available tools, Google Sites stands out as an accessible and customizable platform for developing web-based instructional materials. As a product within the Google Workspace ecosystem, Google Sites allows educators to integrate multimedia resources, assignments, and feedback mechanisms in a centralized, user-friendly interface [19], [20]. In vocational contexts, this can facilitate independent learning, support flipped-classroom models, and enable project documentation and portfolio-based assessment—all of which are aligned with the principles of PjBL. However, empirical evidence on the impact of Google Sites as a digital learning medium in vocational education remains limited.

Furthermore, while previous studies have explored the application of various Learning Management Systems (LMS) and digital tools, most focus on higher education or general secondary education. There is a notable gap in research that targets vocational high schools and examines how specific platforms like Google Sites, when integrated with PjBL, affect learning outcomes in specialized technical fields such as Network System Administration.

To address this research gap, the present study explores the implementation of Google Sites-based learning media using a PjBL model to improve student engagement and learning outcomes in a vocational high school setting in Indonesia. Through a classroom action research (CAR) approach, this study evaluates the effectiveness of this integrated model in enhancing students' attendance, task completion, and academic performance in Network System

Administration among grade XI TKJ (Computer and Network Engineering) students at SMK Negeri 5 Padang.

The study contributes to the growing body of literature on digital transformation in vocational education by providing practical insights and empirical data on how freely available web-based tools can be utilized to support student-centered learning in low-resource educational settings. It also offers a replicable model for integrating technology with pedagogical strategies that are aligned with industry-relevant competencies.

2. Material and methods

2.1 Research Design

This study employed a Classroom Action Research (CAR) methodology with a two-cycle implementation, structured around four main stages: planning, acting, observing, and reflecting. CAR is an iterative approach that allows educators to diagnose problems in instructional practice and test pedagogical interventions in real time. The primary aim of this study was to examine the effect of Google Sites-based learning integrated with the Project-Based Learning (PjBL) model on students' learning engagement and academic achievement in the subject of Network System Administration.

2.2 Research Context and Participants

The research was conducted at SMK Negeri 5 Padang, a vocational secondary school in West Sumatra, Indonesia, during the second semester of the 2023/2024 academic year. The participants were students from class XI TKJ (Computer and Network Engineering), consisting of 31 students (24 males and 7 females) who were selected purposively based on their enrollment in the course and access to internet-enabled devices. Table 1 presents a demographic breakdown of the participants.

Table 1. Participant Demographics

Gender	Number of Students	Percentage (%)
Male	24	77.42
Female	7	22.58
Total	**31**	**100**

2.3 Intervention and Learning Materials

The learning intervention involved the design and implementation of a custom-developed Google Sites web page that served as a centralized learning portal. The site included instructional content, interactive videos, downloadable worksheets (LKPD), and project assignments aligned with the PjBL model. The

course topic focused on static routing configuration using Cisco Packet Tracer, a simulation tool widely used in network training. The learning activities followed six phases of the PjBL framework: defining the project, planning steps, scheduling, execution with monitoring, reporting and presentation, and evaluation.

Through this digital platform, students could access learning resources asynchronously, review materials independently, and complete structured project tasks while receiving feedback from teachers. This approach aimed to foster active engagement, critical thinking, and collaborative learning.

2.4 Data Collection Instruments

Data were collected using three complementary instruments. First, observation checklists were used during classroom activities to measure student participation, attentiveness, and task completion. Second, achievement tests were administered at the end of each cycle to assess cognitive gains related to network administration concepts. These tests included multiple-choice and short-answer items aligned with the curriculum. Third, field notes and documentation, including student work samples and screenshots of project outcomes, were gathered to enrich the qualitative analysis.

2.5 Research Procedure

The research was conducted from February to April 2024, with each action research cycle implemented over approximately four weeks. The first cycle involved the introduction of Google Sites and initial project work, while the second cycle refined the instructional strategy based on reflection from the previous cycle. During the planning stage, the researchers developed digital content, lesson plans, and assessment rubrics. In the action stage, students engaged with the Google Sites platform and completed project-based tasks in groups. The observation stage included classroom monitoring and test administration. Finally, in the reflection stage, student performance data and observations were analyzed to inform improvements for the next cycle.

2.6 Data Analysis

Data analysis combined quantitative and qualitative approaches. Student learning outcomes were analyzed using mean scores and classical completeness percentage. A student was categorized as "complete" if their post-test score met or exceeded the minimum passing grade of 75. Comparisons were made across three phases: pre-cycle (baseline), post-cycle I, and post-cycle II. Table 2 presents the progression of student performance across the research cycles.

Table 2. Improvement of Student Learning Outcomes

Phase	Average Score	Number of Students Completed	Completion Rate (%)
Pre-Cycle	67.42	21	68.00
Post-Cycle I	74.11	25	81.00
Post-Cycle II	78.86	28	90.00

In addition to academic scores, student activity indicators were also analyzed. Attendance increased from 74% in the pre-cycle, to 83% in Cycle I, and 89% in Cycle II. Task completion followed a similar trend: 61% in the pre-cycle, increasing to 73% in Cycle I, and 82% in Cycle II. These indicators provided supporting evidence of improved student engagement as a result of the intervention.

2.7 Ethical Considerations

This study adhered to standard ethical protocols for classroom-based educational research. Informed consent was obtained from school authorities, and participation was voluntary. No personally identifiable student data were published. Ethical clearance was approved by the Department of Electronics Engineering Education, Universitas Negeri Padang.

3. Results and discussion

3.1 Results

3.1.1 Initial Condition Description of Learning Outcomes

The initial condition of student learning activities in the subject of Network System Administration Elements for Grade XI TKJ students at SMKN 5 Padang was observed based on three indicators: attendance, task completion, and learning mastery. The results are summarized in Table 1.

Table 3. Initial Condition of Learning Activity Indicators

Indicator	Percentage (%)
Attendance	74
Task Completion	61
Learning Mastery	58

Table 1 illustrates that before the implementation of the intervention, student learning engagement was relatively low. Only 74% of students attended class regularly, 61% completed their assignments, and 58% achieved the minimum learning mastery criteria.

Further detail regarding individual learning outcomes before the intervention is shown in Table 2.

Table 4. Learning Outcomes in the Pre-Cycle Phase

Number of Students	Passed	Percentage (%)
31	21	68

Table 2 shows that out of 31 students, only 21 (68%) achieved the passing grade threshold. This indicated the necessity for improvement in the teaching approach to enhance student performance.

3.2 Cycle I Results

Learning was conducted using Google Sites-based interactive media and the Project-Based Learning (PjBL) model. The content focused on the topic of network topology and architecture. Observations were conducted by a collaborating teacher. The implementation rate of the lesson plan was 75%.

The observation in Cycle I indicated that some learning indicators—such as class discussion feedback and reward mechanisms—were not fully implemented due to time constraints.

Table 5. Learning Activity Indicators in Cycle I

Indicator	Percentage (%)
Attendance	83
Task Completion	73
Learning Mastery	68

Table 3 shows improvements in all aspects of student activity compared to the pre-cycle phase. Attendance increased to 83%, task completion reached 73%, and learning mastery rose to 68%. However, these values still fell short of the success criteria, necessitating a second cycle.

3.3 Cycle II Results

In Cycle II, the lesson continued with topics on the OSI model and network architecture design. All planned learning steps were fully implemented with 83% adherence to the designed lesson plan.

Table 6. Learning Activity Indicators in Cycle II

Indicator	Percentage (%)
Attendance	89

Indicator	Percentage (%)
Task Completion	82
Learning Mastery	78

Table 4 presents a notable increase across all learning indicators. Attendance reached 89%, task completion 82%, and mastery 78%. This suggests that the improved implementation of interactive Google Sites media and the PjBL model had a significant positive impact.

3.4 Improvement in Student Learning Activities

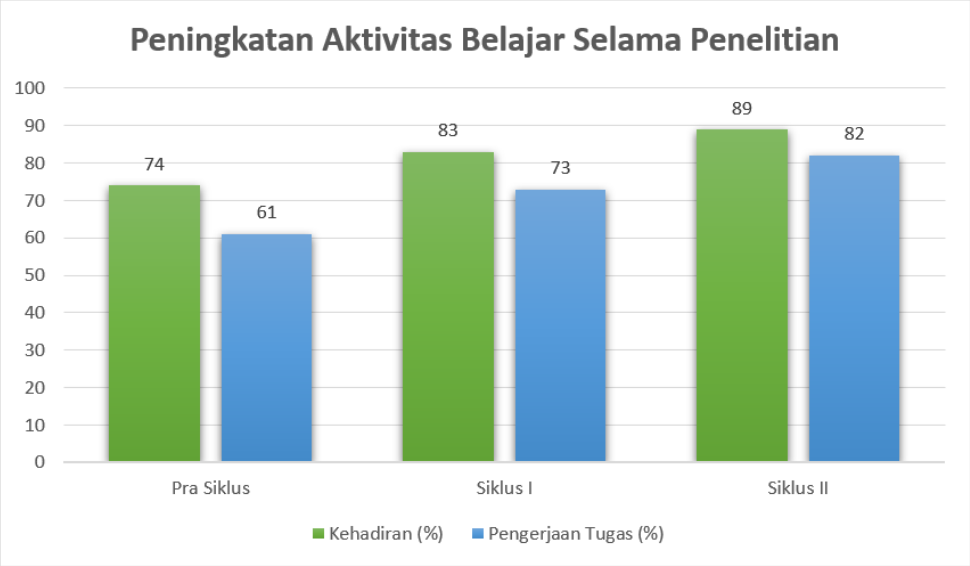

Figure 1. Improvement in Student Learning Activities

Figure 1 visualizes the progressive enhancement in student learning activities throughout the study. Attendance improved from 74% (pre-cycle) to 83% (Cycle I), and to 89% (Cycle II). Task completion followed a similar trend, increasing from 61% to 73%, and then to 82%.

3.5 Improvement in Learning Outcomes

Table 7. Average Student Learning Outcomes

Phase	Average Score	Number Passed	Percentage Passed (%)
Pre-cycle	67.42	21	68
Cycle I	74.11	25	81
Cycle II	78.86	28	90

Table 5 highlights a steady increase in students' average learning scores and the number of students who passed. From the pre-cycle to Cycle II, the average score improved by 11.44 points. Mastery increased from 68% to 90%.

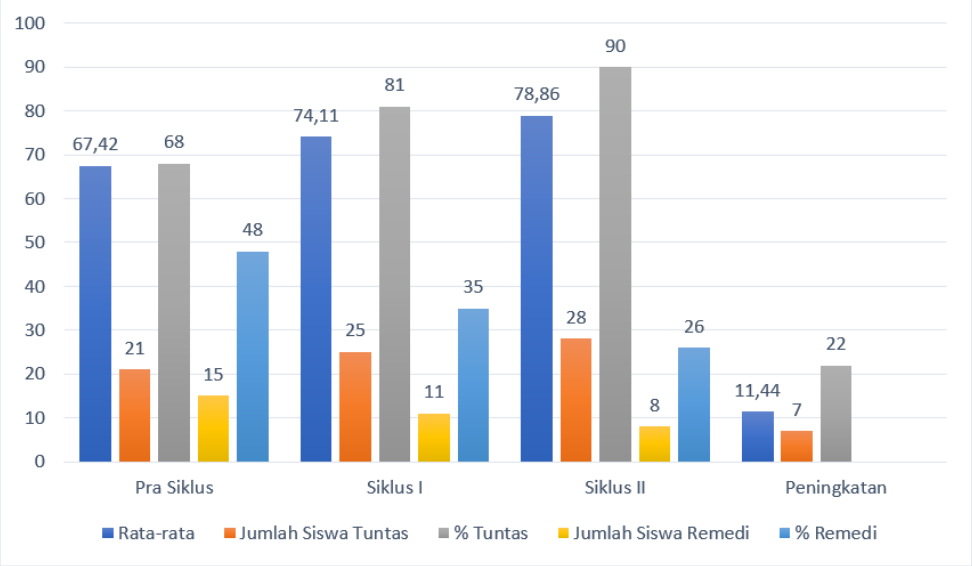

Figure 2. Graph of Learning Outcomes Improvement

Figure 2 graphically illustrates the significant rise in student achievement. The visual emphasizes that the integration of Google Sites and the PjBL model had a tangible and meaningful impact on students' understanding and performance in network system administration.

3.6 Discussion

The results of this classroom action research (CAR) demonstrate a significant improvement in student learning outcomes and learning engagement after the implementation of web-based learning media using Google Sites combined with the Project-Based Learning (PjBL) model. Prior to the intervention, the percentage of student learning mastery was only 68%, with an average score of 67.42. After two learning cycles, mastery increased to 90%, and the average score reached 78.86, indicating an 11.44-point improvement. This pattern also extended to attendance and task completion indicators, both of which increased across cycles, reinforcing the positive effect of the implemented model.

These findings validate the pedagogical effectiveness of the PjBL model in vocational education. PjBL encourages student-centered learning through active problem-solving and collaboration, which are particularly beneficial in technical and skill-oriented subjects such as network administration. This approach aligns with previous studies which confirm that project-based approaches support critical thinking and improve student engagement in authentic tasks [21]–[23].

The integration of Google Sites as a learning platform further strengthened the learning process. Its structured interface provided centralized access to learning materials, videos, worksheets, and evaluation tools. Asynchronous features allowed students to revisit concepts independently, supporting self-regulated

learning. Web-based media has been shown to be effective in increasing both motivation and learning outcomes in digital learning environments [24]. Moreover, access to resources beyond the classroom facilitated greater autonomy in learning, which is essential in preparing students for industry-relevant skills [25].

The combination of Google Sites and PjBL also addressed the limitations of traditional teacher-centered methods that often fail to engage students in vocational education. The digital environment encouraged collaboration and allowed for differentiated instruction based on individual pacing, which is in line with the principles of flexible learning [26]–[28]. Additionally, the use of simulations such as Cisco Packet Tracer and embedded tutorial videos provided multimodal learning experiences, which have been associated with improved conceptual understanding in computer network instruction [29], [30].

Another key factor contributing to the success of this intervention was the systematic implementation of the CAR process itself. By using iterative cycles—consisting of planning, acting, observing, and reflecting—the research ensured continuous refinement and adaptation based on student responses. The use of reflective teaching practices has been widely acknowledged as a powerful mechanism for improving instructional quality [31], [32].

Despite the success achieved, the study also faced some limitations. For instance, in Cycle I, not all instructional components such as reward mechanisms and class discussions were fully implemented, which may have influenced the observed results. However, adjustments made in Cycle II resulted in full implementation and a significant performance gain. This finding suggests that fidelity to instructional design and teacher preparedness are critical in realizing the full benefits of digital and project-based interventions [33]–[35].

In summary, the integration of Google Sites and PjBL was found to significantly enhance student learning outcomes and participation in vocational education settings. This research confirms the potential of combining digital media and constructivist models to support competency-based learning in technical subjects. Future studies are encouraged to expand the sample size, include control groups, and examine long-term retention effects in similar instructional settings.

4. Conclusion

This study concluded that the integration of Google Sites as a web-based learning media, in combination with the Project-Based Learning (PjBL) model, significantly improved student learning outcomes and engagement in the Network System Administration subject for vocational high school students. The research, conducted through two cycles of Classroom Action Research

(CAR), demonstrated a progressive increase in student attendance, task completion, and learning mastery—from an initial mastery level of 68% to 90% by the second cycle, with an average score improvement from 67.42 to 78.86.

The application of Google Sites provided a structured, accessible, and user-friendly digital environment, enabling students to engage in independent learning while still being guided through project-based activities. Meanwhile, the PjBL model encouraged problem-solving, collaboration, and authentic learning experiences aligned with students' future workplace contexts. These findings affirm the effectiveness of combining digital platforms with constructivist instructional models in vocational education.

However, this research is not without limitations. The study was conducted on a relatively small sample (31 students) within a single institution, which may affect the generalizability of the results. Additionally, the research only measured short-term learning gains without evaluating long-term retention or post-course application of skills in real-world settings. The impact of individual differences in digital literacy and self-regulation skills was also not examined in depth.

Future research should consider expanding the study to multiple schools and diverse vocational subjects to assess broader applicability. It would also be beneficial to integrate a control group for comparative analysis, include qualitative assessments of student experiences, and explore the long-term effects of digital project-based learning on student competencies and workplace readiness. Furthermore, future studies could investigate the integration of learning analytics within Google Sites to monitor real-time student progress and personalize learning support.

Author's declaration

Author contribution

Wici Aan Savitri contributed to the research design, classroom implementation, data collection, and initial manuscript drafting. Firdaus contributed to the methodology design, data analysis, critical revision of the manuscript, and ensured the academic rigor of the study throughout the research process. Both authors have read and approved the final version of the manuscript.

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Competing interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Ethical clearance

This study was conducted in accordance with institutional guidelines and was approved by the academic research ethics committee of the Department of Electronics Engineering, Universitas Negeri Padang. Prior consent was obtained from the school, and student data was anonymized to maintain confidentiality.

AI statement

This article is the author's original work, written from original research and no sections or figures are generated by AI. English is checked using Grammarly and has been verified by the authors.

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