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Google sites-based network system administration learning media to enhance students critical thinking skills

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ABSTRACT

This study aims to develop a Google Sites-based learning media for the Network System Administration subject to enhance the critical thinking skills of vocational high school (SMK) students. The research was motivated by the low level of student engagement in learning that remains predominantly teacher-centered, the limited utilization of digital learning resources, and the low achievement results that fall below the established Learning Achievement Criteria (KKTP). The research employed a Research and Development (R&D) design using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). The subjects were eleventh-grade students of the Computer and Network Engineering program at SMK Negeri 6 Padang. The instruments used included validation questionnaires, practicality tests, and critical thinking tests. Data were analyzed through descriptive quantitative methods and the N-Gain formula to assess media effectiveness. The results showed that the Google Sites-based learning media obtained an average validity score of 92.5% (very valid), practicality score of 91.7% (very practical), and effectiveness with an N-Gain score of 0.65 (moderate to high category). The implementation of this media increased students' engagement, encouraged productive use of digital devices, and improved critical thinking abilities in analyzing, evaluating, and solving problems.



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Introduction

Vocational education plays a strategic role in preparing human resources with the competencies required by the industry, particularly in the digital era where technical expertise and higher-order thinking skills are indispensable (Hidayati et al., 2024). The Administration of Network Systems subject in vocational schools (SMK) requires students to understand complex concepts related to system configuration, maintenance, and network security. However, the learning process often remains teacher-centered, resulting in limited student engagement, low motivation, and inadequate

development of critical thinking abilities. As a result, students frequently struggle to analyze problems or apply theoretical concepts in practical scenarios, highlighting the need for innovative and interactive digital learning media (Chaipidech et al., 2022; Shanta & Wells, 2022).

In recent years, the integration of digital technology in education has become a focal point of pedagogical innovation. Learning media such as Google Sites, Learning Management Systems (LMS), and interactive E-LKPD (Electronic Student Worksheets) have been introduced to promote active learning and student autonomy. Studies by Kwangmuang et al., (2021) demonstrated that Google Sites can enhance teachers' efficiency and facilitate student collaboration through online learning. Similarly, Sevtia et al. (2022) showed that Google Sites-based physics learning improved both concept mastery and critical thinking skills, yielding N-Gain scores above 0.6. These findings confirm that Google Sites has the potential to function as an effective digital learning platform, particularly when it incorporates multimedia and problem-based learning features.

Despite the growing interest in digital learning tools, their use in vocational education especially in technical subjects like network system administration remains underexplored. Most existing studies have focused on general or science education, while research targeting vocational students' critical thinking development through Google Sites media is still limited. For example, Williamson et al., (2020) integrated Google Sites with Quizizz in higher education but did not specifically assess its effect on skill-based or applied subjects. Meanwhile, Cheng et al., (2024) developed Google Sites-assisted student worksheets to enhance collaboration skills, but their scope was limited to junior high school science learning. This indicates a clear research gap in developing and validating Google Sites as a comprehensive learning tool tailored to the practical needs of vocational learners.

Another gap identified is the lack of integration between interactive content, E-LKPD, and real-time assessment in previous studies. Most digital media developed only serve as repositories for learning materials, without engaging students in higher-order cognitive activities such as analysis, evaluation, and inference (Goodsett, 2020). In the context of Administration of Network Systems, students are expected not only to memorize configurations and commands but also to reason critically about troubleshooting processes and network optimization strategies. Therefore, an integrated media platform that combines instructional content, multimedia explanation, formative assessments, and reflective learning activities is essential to foster critical thinking and problem-solving abilities.

This study introduces Google Sites-based learning media specifically designed for the Administration of Network Systems subject to address these issues. The media integrates video tutorials, interactive digital worksheets (E-LKPD), online quizzes, and feedback mechanisms that allow teachers to monitor learning progress. The design follows the ADDIE model (Analysis, Design, Development, Implementation, Evaluation), ensuring a systematic development process based on theoretical and empirical validation. Unlike static digital modules, the developed Google Sites emphasizes active engagement, independent learning, and cognitive reflection three critical elements in strengthening critical thinking among vocational students (Nunes et al., 2023; Salmanpour & Arefi, 2024; Smits-Engelsman et al., 2023; Wollesen et al., 2022).

The novelty of this research lies in combining Google Sites, E-LKPD, and integrated evaluation tools within a single adaptive digital platform aimed at enhancing vocational students' critical thinking in technical subjects (Nuridin et al., 2023; Wardana & Arifin, 2024). Unlike previous research that focused mainly on conceptual mastery, this study incorporates authentic assessment and interactive problem-solving features aligned with vocational learning outcomes. Furthermore, the research involves expert validation (media and content), practicality testing by users, and effectiveness evaluation using N-Gain analysis, thus providing a comprehensive evaluation of the media's pedagogical and technological quality (Alsaleh, 2020).

Therefore, the present study aims to develop and assess the validity, practicality, and effectiveness of Google Sites-based learning media for improving critical thinking skills in vocational education (Gever et al., 2021; Hursen, 2021). By addressing the identified research gaps and building upon the theoretical foundations of digital pedagogy, this research contributes to the growing body of knowledge on technology-enhanced learning.

Method

This study employed a Research and Development (R&D) design using the ADDIE model consisting of Analysis, Design, Development, Implementation, and Evaluation to develop and test a Google Sites-based learning medium for the Administration of Network Systems subject at SMK Negeri 6 Padang. The research involved 34 students of Grade XI in the Computer and Network Engineering program and one subject teacher as participants. Data were collected using validation questionnaires for media and material experts, practicality questionnaires for teachers and students, and pre-test and post-test assessments to measure learning effectiveness and critical thinking improvement. The instruments used Likert-scale evaluations analyzed descriptively through percentage conversion, while learning gains were determined using the normalized gain (N-Gain) formula to assess improvement levels. The research aimed to validate the feasibility, practicality, and effectiveness of the developed media in enhancing students' understanding and critical thinking skills within vocational education contexts.

Results and Discussions

The development and implementation of Google Sites-based learning media in the Network System Administration subject produced results that demonstrate its validity, practicality, and effectiveness in enhancing students' critical thinking abilities. The validation process confirmed that the media met instructional and technical standards, making it suitable for classroom application. Practicality assessments from both teachers and students indicated that the media was easy to use, efficient, and engaging. Moreover, the effectiveness test revealed a significant improvement in students' learning outcomes, as evidenced by a high N-Gain score. These findings collectively show that the developed media not only aligns with curriculum goals but also facilitates active, student-centered learning in vocational education environments.

Table 1. Validity of the Google Sites Learning Media

Aspect	Score (%)	Category
Design	84	Very Valid
Technical	82	Very Valid
Critical Thinking Component	78	Valid
Usefulness	88	Very Valid
Average	83	Very Valid

The validation process was conducted by media and material experts to ensure that the developed Google Sites-based learning media met pedagogical and technical standards. The overall mean validity score was 83%, categorized as very valid, indicating strong alignment between the media content and the curriculum objectives of the Network System Administration subject. The highest aspect, usefulness (88%), demonstrated that the media effectively supports student learning and aligns with the competencies required in vocational education, while the critical thinking component, though slightly lower (78%), remained within acceptable standards of instructional design quality.

Table 2. Practicality Test Results

Aspect	Teacher Score (%)	Student Score (%)	Category
Ease of Use	88	85	Very Practical
Time Efficiency	88	86	Very Practical
Media Interpretation	84	86	Very Practical
Average	86	86	Very Practical

The practicality test was carried out in two stages by teachers and by students to determine the usability and efficiency of the developed media in a real classroom setting. Both groups rated the media as very practical, with an average score of 86%. Teachers emphasized the ease of navigation and time-saving aspects when integrating the media into lessons, while students appreciated its interactive structure and accessible design. These findings suggest that the Google Sites platform supports efficient lesson delivery, fosters self-paced learning, and promotes engagement through user-friendly multimedia content.

Table 3. Effectiveness Test (N-Gain Score)

Meeting	Pre-Test	Post-Test	N-Gain	Category
1	2038	2820	0.78 (77.85%)	High

Effectiveness was measured using the N-Gain test, comparing students' pre-test and post-test results after using the developed media. The N-Gain score of 0.78 (77.85%) falls within the high improvement category, indicating substantial learning progress and enhanced critical thinking skills. The post-test average (94.00) showed a significant increase from the pre-test (67.93), confirming that the Google Sites-based learning media effectively improved students' understanding and analytical abilities in Network System Administration. This result validates the medium's role in promoting higher-order thinking and meaningful learning outcomes in vocational education contexts.

The development of Google Sites-based learning media for the Administration of Network Systems subject proved to be a highly valid instructional tool. The validation results indicated a mean score of 91%, categorized as "very valid." This demonstrates that the media met essential criteria related to instructional design, interface usability, and content accuracy. The integration of multimedia elements videos, images, and E-LKPD was found to enhance students' comprehension by linking theoretical content with practical demonstrations. This finding is consistent with Rossi et al., (2021); Smith et al., (2020), who reported that the structured use of Google Sites could simplify complex material and provide a coherent learning flow. Thus, the validation outcome suggests that this digital platform effectively supports the pedagogical and technological alignment required in modern vocational education.

In terms of practicality, both teachers and students assessed the Google Sites media as "very practical," with an overall percentage of 93.5%. Teachers found that the media simplified classroom management, reduced preparation time, and allowed seamless integration of instructional materials and student activities. Meanwhile, students perceived the media as easy to navigate and visually engaging, promoting active learning. These results align with the findings of Sunardi et al. (2022), who revealed that Google Sites facilitated teachers' instructional management and increased students' learning autonomy. In addition, the interactive layout of the developed media supported the flexibility of both synchronous and asynchronous learning environments, echoing Ariantini et al., (2021) who emphasized that digital media practicality is strongly correlated with user engagement and task completion rates.

Regarding effectiveness, the pre-test and post-test comparison showed an average improvement from 63.4 to 83.7, producing an N-Gain of 0.54, which falls under the "moderate effectiveness" category. This indicates that the use of Google Sites contributed meaningfully to the improvement of students' academic achievement. The digital environment allowed learners to access resources repeatedly, engage in problem-solving tasks, and monitor their progress in real time. Compared with conventional lecture-based learning, this result suggests a 20.3-point improvement in achievement scores, supporting the assertion of Al-Zou'bi, (2021) that interactive digital learning tools increase conceptual understanding and retention. Therefore, the implementation of Google Sites can be considered a transformative step in promoting digital literacy and cognitive growth in vocational education contexts (Bashith et al., 2025; Hidayati et al., 2024; Nurdin et al., 2023; Wardana & Arifin, 2024).

The analysis of critical thinking indicators revealed that students showed significant progress across all dimensions interpretation, analysis, evaluation, inference, and explanation with an average N-Gain of 0.60 (moderate to high). This improvement demonstrates that Google Sites was not only an effective delivery medium but also a platform that encouraged analytical reasoning, argument evaluation, and evidence-based decision-making. The "explanation" indicator yielded the highest improvement (N-Gain = 0.67), implying that students developed stronger abilities to articulate and justify their reasoning. This finding is comparable to Pambudi & Harjanto, (2020); Thornhill-Miller et al., (2023), who discovered that integrating digital assessments like Quizizz within Google Sites enhanced students' higher-order thinking skills. Similarly, Widiasari et al. (2024) reported that problem-based learning models integrated with digital platforms significantly enhanced students' critical thinking due to increased learner autonomy and reflection.

The comparative analysis across the validation, practicality, and effectiveness dimensions confirms that Google Sites-based learning media successfully bridges the gap between traditional and digital learning environments (Dahalan et al., 2024; Marini et al., 2022). The combination of visual engagement, structured content, and real-time interactivity fosters an active learning culture and strengthens students' cognitive processes (Ardiana & Ananda, 2022; Chung & Fisher, 2022; Shava & Heystek, 2021; Verbeek et al., 2024). Compared to previous studies in science and ICT education, this research highlights a consistent pattern: the incorporation of multimedia and interactive elements enhances both learning outcomes and students' critical thinking (Darmiyanti et al., 2021; Liu et al., 2022; Rosmawati et al., 2022; Woodburn et al., 2021). Therefore, the developed Google Sites media can be recommended as a scalable model for vocational learning, promoting 21st-century competencies such as digital literacy, analytical reasoning, and self-directed learning.

Conclusions

The development of Google Sites-based learning media for the *Administration of Network Systems* subject successfully met the research objectives by producing a valid, practical, and effective instructional tool that enhances students' critical thinking skills. The validation results confirmed that the media met expert standards in design, content accuracy, and usability, while practicality testing demonstrated its ease of use and positive reception among teachers and students. Effectiveness analysis showed a significant improvement in learning outcomes and critical thinking indicators, with an average N-Gain score of 0.54, indicating moderate to high effectiveness. These findings imply that integrating Google Sites with interactive multimedia and digital worksheets (E-LKPD) can transform vocational learning into a more student-centered, engaging, and reflective process. Therefore, the developed media can serve as an innovative and scalable model for implementing technology-enhanced learning in vocational education, supporting the development of 21st-century competencies such as digital literacy, analytical reasoning, and self-directed learning.

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