e-ISSN 3090-5354
Vol.1, No.2, August 2025

The Effectiveness of G-Sites-Based Learning to Improve Students' Critical Thinking Skills

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DOI : https://doi.org/10.26740/jdpe.1.2.41960

Sections Info

Article history:
Submitted: June 9, 2025
Final Revised: June 21, 2025
Accepted: June 21, 2025
Published: July 12, 2025

Keywords:
Educational Innovation;
G-Sites;
Interactive;
Learning Media.

ABSTRACT

Objective: *This study aims to develop and evaluate the effectiveness of G-Sites-based learning media to improve students' critical thinking skills, particularly in understanding the physics topic of the electrical obstacle series. With the growing need for engaging and flexible digital learning solutions, this research addresses how interactive web-based media can enhance learning outcomes in science education.* ***Method:*** *The research employed a 3D development model consisting of Define, Design, and Develop. Learning needs were identified through student surveys, and the media was designed using G-Sites, which incorporated features such as videos, quizzes, and interactive simulations. The developed media was validated by experts and tested on 59 high school students in a limited classroom trial at SMAN 1 Ngimbang. Data were analyzed quantitatively using validity scores and gain scores from pre-and post-tests.* ***Results:*** *The validation results showed that the learning media was highly valid in terms of design, content, interactivity, and technical aspects, with scores exceeding 90%. Student learning outcomes improved significantly, as shown by increased post-test scores. Feedback indicated that students found the media engaging, accessible, and preferable compared to conventional methods.* ***Novelty:*** *This study introduces the innovative use of Google Sites as a free, accessible, and flexible platform for developing interactive physics learning media. Unlike many commercial platforms, G-Sites allows educators to independently create customized, multimedia-rich content tailored to their students' needs, representing a practical and scalable solution for digital learning in resource-constrained environments.*

INTRODUCTION

In the era of accelerated information technology, innovation in the world of education is an absolute requirement to improve the quality of learning processes and outcomes. Digital technology enables the transformation from conventional learning to a more flexible and affordable system. One of the significant expectations in the world of education today is the creation of digital learning media that can foster students' motivation and active participation in the learning process (Nababan et al., 2023). Engaging and interactive learning media are expected to foster student involvement both cognitively and affectively, thereby creating a more meaningful and personal learning experience (Nasution & Astuti, 2024).

However, in reality, there are still many physics learning materials that are abstract and difficult for students to understand, one of which is the material on series electrical resistance. This concept requires an understanding of theory, mathematical calculations, and practical relationships that are not easily learned without the aid of representative visualizations or simulations (Doyan et al., 2025). Students' difficulty in understanding

this topic has an impact on low learning outcomes and a lack of critical thinking skills needed to solve problems independently.

On the other hand, the learning approach that is still predominantly lecture-based and textbook-based is no longer able to meet the learning needs of 21st-century students. The lack of visual, interactive, and exploratory elements in learning can lead to a decrease in student interest and motivation, particularly in complex topics such as electrical circuits (Sari & Suswanto, 2023). This is a real problem that requires innovative solutions in the form of technology-based learning media that are easily accessible, structured, and interactive.

Recent literature shows that web-based learning media has great potential in supporting science and physics learning. The advantages of this media include high accessibility, time flexibility, ease of content updates, and cost efficiency (Nababan et al., 2023; Nasution & Astuti, 2024). One platform that supports the development of digital learning media is Google Sites (G-Sites), which allows teachers to easily and free of charge integrate videos, simulations, quizzes, and links to other learning resources (Dewi & Candra, 2024).

The use of G-Sites offers various advantages, including a simple display, multimedia support, and ease of design and navigation. This platform also supports the personalization of learning, allowing it to be adjusted to the characteristics and needs of students, and thus has great potential to increase their engagement and understanding of physics concepts (Lindra et al., 2025). In addition, due to their web-based nature, G-Sites can be accessed through various devices connected to the internet, making them highly relevant in the context of distance learning or blended learning (Wahyuni & Yani, 2024).

However, several limitations remain in the use of G-Sites as a learning medium. Among these are the lack of technical training for teachers in designing effective content, limited features in automatic assessment, and the absence of research that empirically tests the effectiveness of G-Sites in the context of physics learning, particularly in improving students' critical thinking skills (Doyan et al., 2025). These challenges present research opportunities to systematically evaluate and develop the use of G-Sites further.

Based on this background, this study aims to develop G-Sites-based learning media specifically designed to improve students' critical thinking skills in the material of series electrical resistance. This study adopts a structured and tested 3D (Define, Design, Develop) development model. The main novelty of this study lies in its focus on the effectiveness of digital media in the context of complex topics, a free web-based approach that is easy to replicate, and empirical evaluation based on gain scores and expert validation. Thus, the results of this study are expected to serve as a practical reference for physics teachers in implementing innovative learning that is effective, flexible, and relevant to current needs.

RESEARCH METHOD

The development of G-Sites-based learning media for electrical barrier series materials utilizes 3D models, specifically Define (Define), Design (Design), and Development (Development). The R&D method is a process for developing products and evaluating their effectiveness (Cahya & Sucahyo, 2021). Figure 1 is an explanation of each stage.

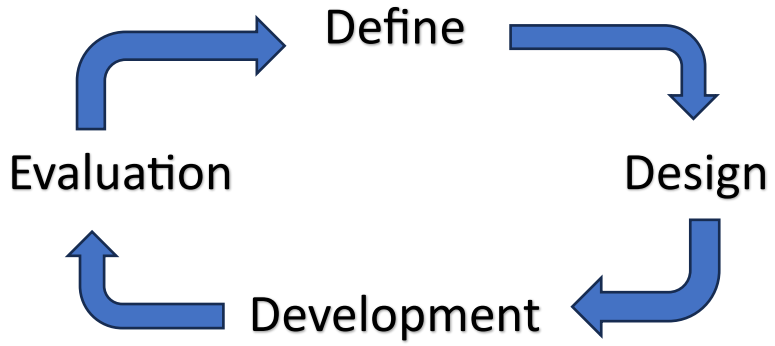

Figure 1. 3D research design

Data collection

This research was conducted with students from SMAN 1 Ngimbang Lamongan, involving a total of 2 classes with 59 students. Two validators validated the instruments used. Instruments related to Google sites-based learning media that researchers have developed. The variables assessed included aspects of design and navigation, content and materials, interactivity, and technical aspects.

Data Analysis

The analysis technique employed in this study is quantitative. At the development stage, the researcher conducts a validity test with the score criteria obtained, such as Table 1

Table 1. Interpretation criteria

Percentage (%)	Interpretation Criteria
0-20	Very invalid
21-40	Invalid
41-60	Quite valid
61-80	Valid
81-100	Very valid

(Riduwan & Akdon, 2013)

Table 1 presents the interpretation criteria for the percentage scores used to assess the validity of the developed learning media. Scores ranging from 0–20% are categorized as very invalid, while scores between 81–100% indicate that the media is very valid (Riduwan & Akdon, 2013). After conducting the validity test based on these criteria, the developed media was then subjected to a limited trial to evaluate its practicality and effectiveness in an actual learning context.

Define

The Define stage aims to identify students' learning needs and characteristics through initial analysis, serving as the foundation for designing learning media that aligns with their abilities, preferences, and challenges.

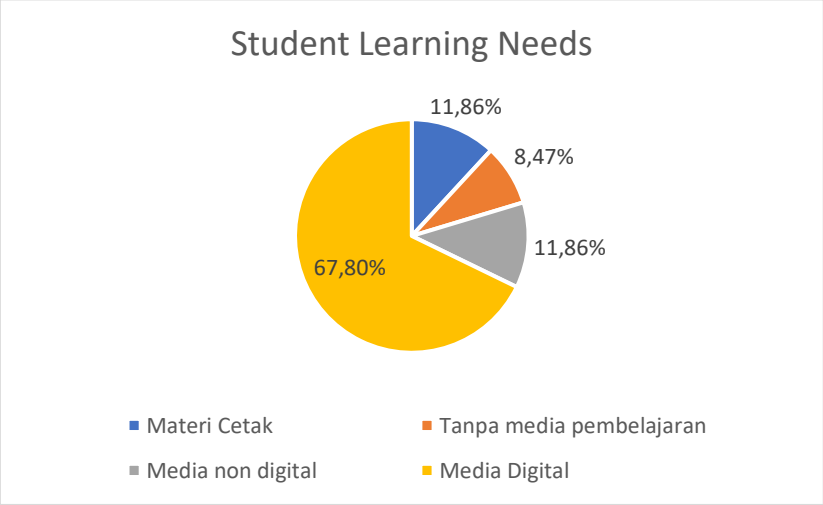

Figure 2. Student learning needs

The data show that 67.80% of students require flexible digital learning media that can be accessed and studied at any time and from anywhere, preferably in the form of a website, to support their learning needs.

Design

At this stage, the design of G-Sites-based learning media is carried out. The steps include:

- Designing a content framework: Creating a content structure based on the results of the analysis at the *Define stage*. The content includes an explanation of the concept of an electrical barrier circuit, visual illustrations, interactive simulations, and practice questions.
- Designing website layouts: Designing an attractive, accessible, and user-friendly G-Sites interface, including color selection, fonts, and navigation.
- Selecting supporting learning resources: Compiling and integrating resources such as learning videos, animations, and links to interactive simulations related to electrical resistance circuits.

Development

The Development stage involves creating G-Sites-based learning media based on the previously prepared design, incorporating multimedia elements such as videos, simulations, and quizzes to ensure alignment with the intended instructional goals.

Table 2. Criteria of validation

Aspects	Validator 1	Validator 2	Average	Criteria
Design and Navigation	90%	90%	90%	Highly Valid
Content and materials	95%	93%	94%	Highly Valid
Interactivity	94%	92%	93%	Highly Valid
Technical	95%	95%	95%	Highly Valid

Table 2 shows the validation results of the G-Sites-based learning media, with all assessed aspects of design and navigation (90%), content and materials (94%), interactivity (93%), and technical quality (95%) receiving average scores above 90%, indicating that the media is categorized as highly valid by both validators.

Evaluation and revision

After the three 3D stages are completed, the learning media is tested more widely in the classroom to evaluate its success in supporting the learning process. Feedback from the Validator is used to make further improvements or developments so that the learning media becomes more optimal.

Table 3. Validator's comment

	Comment
Validator	Simple appearance needs to be designed to be even more attractive
	Much content is exciting and fits the material
	Interactivity is already excellent
	The way it operates is straightforward, like the rest of the web

The validators provided positive feedback on the developed G-Sites-based learning media, noting that while the appearance is simple and could be made more attractive, the content is interesting and relevant to the material, the interactivity is excellent, and the media is easy to operate, similar to other commonly used websites.

RESULTS AND DISCUSSION

Results

Learning with Google Sites, especially in the Electricity obstacle series material, provides a unique experience for students, allowing them to adjust to their learning style by utilizing features such as videos, virtual labs, quizzes, and links to other learning resources.

Figure 3. Front view image

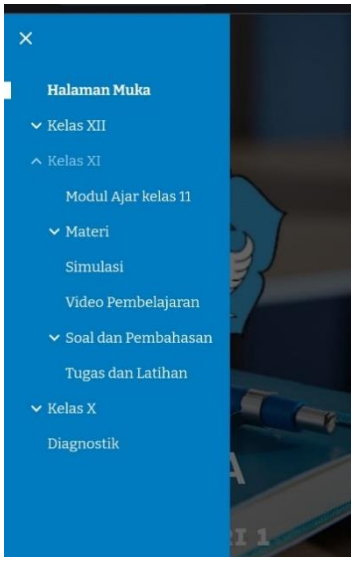

Figure 4. Menu view image

In its use, G-Sites features a simple and user-friendly interface and menu, making it easy to operate and attractive. The advantage of learning with this Google Sites media is that students can learn anywhere and at any time, as long as they have access to devices and internet connections. In the three-line icon option, there are menus needed for student learning according to their level. The convenience provided by this Google Sites learning media makes it a preferred option over using printed books or conventional learning methods. This will further increase students' interest in learning more about physics subjects, and for teachers, it will also be a significant help in delivering material to students. This digital-based teaching material has been proven to increase students' interest in learning and can improve student learning outcomes (Farhana et al., 2021).

Figure 5. Material menu images

Figure 6. Simulation menu images

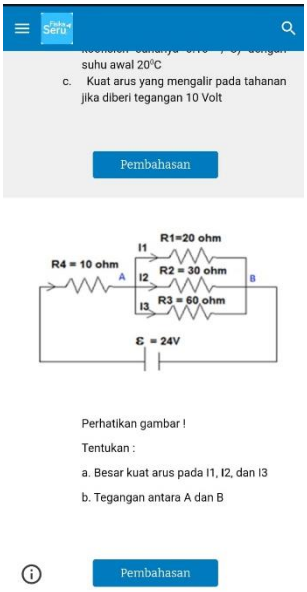

Figure 7. Question and discussion menu Images

In this learning media, there is a material menu that contains all Physics subject matter taught according to the level. There is also a simulation menu connected to PhET Colorado, which is equipped with practical instructions to help students conduct their experiments. The results of research that have been carried out by testing the limited learning media of Googlesites in grade XII, as many as 59 students at SMAN 1 Ngimbang, show that Googlesites-based learning media from the aspect of interactivity and material is excellent, showing an average number of > 3.5 while the aspect of display and user convenience is still below.

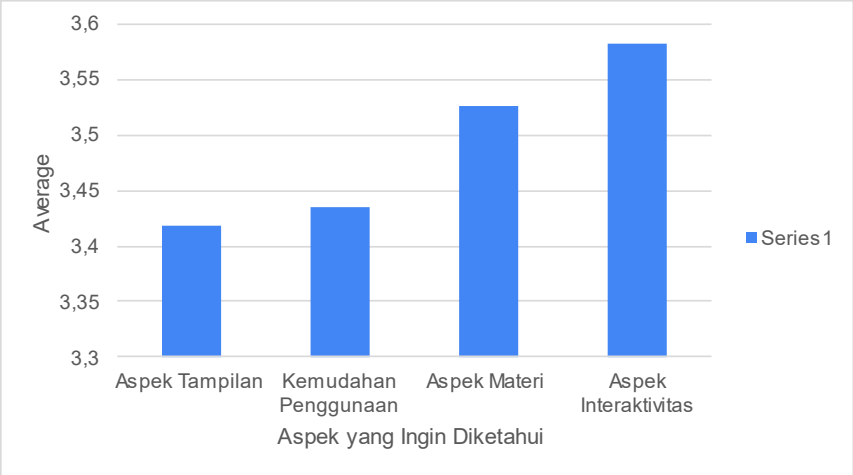

Figure 5. Aspects of learning media

Media Eligibility

- The learning media developed is considered suitable for use based on validation from media and material experts.
- A media eligibility score is typically in the "excellent" category with a certain percentage (e.g., >80%), indicating that the media meets the criteria for interactive and relevant learning.

Practicality

- Based on trials with teachers or students, G-Sites-based media is considered practical and accessible, both through computer devices and mobile phones.
- Features such as interactivity (online quizzes, simulations, or video tutorials) improve students' understanding of the material.

Media Effectiveness

- Effectiveness tests were carried out through measuring the improvement of student learning outcomes before and after using the media (pre-test and post-test).
- The results showed a significant increase in the average score of students, for example from the low to medium/high category, with *a significant* gain score.

User Feedback

- Students feel more interested in learning using interactive media than conventional methods.
- Teachers find it helpful in delivering complex material such as electrical barriers because the medium provides clear visualization.

Discussion

The results of this study demonstrate that G-Sites-based learning media is efficacious in improving students' critical thinking skills, particularly on the topic of electrical obstacle series. This is evident from the significant increase in students' post-test scores, supported

by gain score analysis and reinforced by positive feedback from both validators and students. The high average validity score above 90% in all assessed aspects—design and navigation, content and materials, interactivity, and technical feasibility—indicates that the media fulfills essential quality standards for learning tools (Riduwan & Akdon, 2013).

This finding aligns with the research objective of developing and evaluating the effectiveness of interactive, accessible, and web-based learning media. The choice of G-Sites as a platform proves to be a practical solution in digital media development, especially in resource-limited educational contexts. Similar studies have found that integrating web-based platforms with multimedia features, such as videos, simulations, and quizzes, enhances students' conceptual understanding and cognitive engagement (Dewi & Candra, 2024; Mayer, 2001).

Several studies support the notion that interactive digital learning media can significantly influence the development of students' critical thinking. For example, Wahyuni and Yani (2024) reported that PBL-based Google Sites media improved not only critical thinking but also collaboration skills in science classes. Likewise, Khaeruddin and Bancong (2022) emphasized that embedding PhET simulations within a STEM framework helps students analyze and evaluate problems systematically, which are core components of critical thinking.

The increase in student performance in this study also supports earlier findings by Mariani et al. (2022), who used Google Sites in physics classes and found improvements in students' problem-solving skills. Additionally, Saputra et al. (2025) found that the critical thinking abilities of elementary students were significantly enhanced when using web-based interactive media compared to traditional instruction. This confirms that digital platforms—when well-designed—can be effective at multiple educational levels.

Furthermore, this study provides practical implications for the development of instructional design. The Define-Design-Develop (3D) model used in this study ensured that the resulting media was grounded in actual student needs, content structure, and appropriate technological integration. The emphasis on user feedback and iterative validation strengthens the practical utility of the media in classroom implementation. This aligns with the instructional design principles proposed by Gagné and Briggs (1974) and the multimedia learning theory by Mayer (2001), which advocate structured and meaningful integration of visual and interactive elements in teaching.

Despite the generally positive results, some areas for improvement remain. Feedback from validators suggested that, while the content and interactivity were strong, the visual layout could be improved to make it more attractive. This echoes the findings by Lindra et al. (2025), who emphasized the importance of aesthetic appeal and usability in influencing students' learning engagement. Additionally, students' feedback indicated that although the media was easy to use, further improvements in design could enhance their learning experience even more.

In terms of novelty, this study stands out by evaluating the effectiveness of Google Sites-based learning media on a specific physics topic—electrical obstacle series—which has rarely been explored in previous research. Most prior studies focused on general science topics or broader platforms, whereas this study provides specific pedagogical and technical insights that can be replicated and expanded upon. The study also contributes

to filling the research gap regarding the quantitative impact of Google Sites on critical thinking, a key 21st-century competency.

In conclusion, the findings validate the potential of G-Sites-based learning media to improve students' critical thinking skills, aligning with the research objectives. By situating this study within the existing literature, it becomes evident that integrating well-designed digital learning tools, particularly through accessible platforms like Google Sites, can transform traditional learning into a more meaningful and student-centered process. Future research could expand this approach to different topics and educational levels, incorporate collaborative learning strategies, or compare different web-based platforms to identify optimal conditions for digital learning success.

CONCLUSION

Fundamental Finding: The study found that G-Sites-based learning media is highly effective in improving students' understanding and critical thinking skills, particularly in the topic of electrical obstacle series. The media demonstrated high levels of validity across design, content, interactivity, and technical criteria, with average expert validation scores exceeding 90%. Its user-friendly design and integration of multimedia elements (videos, simulations, quizzes) significantly enhanced student engagement and learning outcomes, as shown by improvements in post-test scores and positive user feedback. **Implication:** These findings highlight the crucial role of digital platforms, such as G-Sites, in transforming conventional teaching into interactive, student-centered learning. The success of this approach supports the broader adoption of free, web-based technologies in science education, which not only accommodate various learning styles but also increase accessibility and flexibility. Teachers can use similar frameworks to enhance instructional quality and foster critical thinking among students, which is essential for 21st-century competencies. **Limitation:** The research was conducted within a limited scope, focusing solely on students from SMAN 1 Ngimbang and a single topic in physics. Additionally, while user feedback was generally positive, aspects related to display and ease of use still showed room for improvement. The study also did not explore the long-term retention or cross-topic effectiveness of the learning media. **Future Research:** Future studies should expand the application of G-Sites-based learning to a broader range of physics topics and diverse student populations to test its scalability and generalizability. Comparative studies involving other digital platforms or learning management systems could offer deeper insights into optimal digital learning strategies. Furthermore, exploring the impact of such media on collaborative learning, problem-solving, and the development of long-term critical thinking would enrich the understanding of digital media's role in education.

AUTHOR CONTRIBUTIONS

Akhmad Iswardani: Conceptualization, Methodology, Formal Analysis, Writing – Original Draft, Visualization; **Budi Jatmiko**: Supervision, Validation, Writing – Review & Editing, Project Administration; **Eko Hariyono**: Methodology, Resources, Writing – Review & Editing, Validation; **Habibi**: Investigation, Writing – Original Draft; **Muhammad Rey Dafa Ahmadi**: Investigation, Writing – Original Draft. All authors have read and approved the final version of this manuscript.

DECLARATION OF COMPETING INTEREST

The authors declare no known financial conflicts of interest or personal relationships that could have influenced the work reported in this manuscript.

DECLARATION OF ETHICS

The authors declare that the research and writing of this manuscript adhere to ethical standards of research and publication, in accordance with scientific principles, and are free from plagiarism.

DECLARATION OF ASSISTIVE TECHNOLOGIES IN THE WRITING PROCESS

The authors declare that generative artificial intelligence (Gen AI) and other AI-assisted tools were used prudently, not excessively, during the research and preparation of this manuscript. Specifically, ChatGPT was used for outlining and refining the structure of the manuscript and formulating scientific explanations; Grammarly for grammar and style corrections; and ChatPDF for extracting and summarizing key points from references. All AI-generated material was reviewed and edited for accuracy, completeness, and compliance with ethical and scholarly standards. The authors accept full responsibility for the final content of the manuscript.

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