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Development of Interactive Learning Media Based on Google Sites In Physics Learning for Class XI

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Abstract: This study aims to develop a valid, practical, and effective Google Sites-based interactive learning media for Grade XI Physics. The research employed the Research and Development (R&D) method, utilizing the 4D development model which consists of four phases: Define, Design, Develop, and Disseminate. The data sources included assessments from experts, educators, and students, which described the level of validity, practicality, and effectiveness of the developed media. The validity test results indicated that the Google Sites-based interactive learning media is suitable for implementation in the learning process according to experts. The responses from educators and students also demonstrated that the media is practical for use in learning. The effectiveness test results revealed that the developed interactive learning media is effective in improving student learning outcomes, with an N-Gain score of 0.76 for the knowledge aspect. Meanwhile, for the skills aspect, it was categorized as moderately effective with an N-Gain score of 0.73. Therefore, the Google Sites-based interactive learning media is valid, practical, and effective for use in the Physics learning process.

Keywords: Google sites; Interactive learning media; Physics

Introduction

The global education sector is undergoing a transformation towards the Society 5.0 Era, a human-centered concept based on technology as a solution to the degradation of the human role in the Industry 4.0 Era (Rohayati & Abdillah, 2024; Suherman et al., 2020). In this context, technology does not replace humans but is integrated to enhance the quality of life (Piardi et al., 2024; Sugiono, 2020). This paradigm shift demands that learning processes leverage technological advancements to create broader, more accessible, and meaningful educational access (Gamage et al., 2023; Suherman et al., 2020). Technological progress also drives the evolution of learning theories, one of which is connectivism, which emphasizes that learning occurs through networks where individuals construct knowledge via connections with other learning resources facilitated by technology (Chen & Chan, 2024; Rahma et al., 2023; Siemens, 2008). This theory supports the creation of open, collaborative environments, enabling learners to interact with various sources and participate actively (Kivunja, 2014; Siemieniecka et al., 2017). This evolution necessitates corresponding innovations in educational practices and tools.

Aligning with global trends, education in Indonesia has established policies encouraging the use of technology in learning (Kemendikbudristek, 2022; Susanto et al., 2022). Physics, as a compulsory subject at the senior high school level (Kemendikbudristek, 2024), plays a critical role as a branch of science that trains analytical skills and forms the foundation for modern technology (Mitrevski, 2019; Ploj Virtič, 2022). Although it fundamentally discusses fascinating natural phenomena (Rasyid et al., 2024), in practice, Physics is often less popular among students (Liswar et al., 2023; Rizaldi & Fatimah, 2024). Low motivation, easily distracted attention, and difficulties in understanding material, particularly those requiring higher-order thinking skills, are widely reported problems (Ady &

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Warliani, 2022; Amalissholeh et al., 2023). These challenges highlight the need for more engaging instructional approaches in Physics education.

The urgency of this research lies in the gap between the potential of technology-based learning and the reality on the ground. Initial observations at SMAN 1 Panti, Pasaman Regency, confirmed these national findings. The learning process is still dominated by the use of conventional media such as PowerPoint and textbooks, leading to teacher-centered instruction. This aligns with reports by McLean et al. (2017) and Delvita et al. (2025) that such practices are still common. As a result, active student participation in developing knowledge, attitudes, and skills remains low (Alayda et al., 2022; Dzikrina & J, 2024). Evaluation data from class F3 at SMAN 1 Panti showed that only 9.68% of students achieved the "proficient" category, while 25.80% were still in the "beginning" category. This situation demonstrates the critical urgency to develop innovative solutions to address the gap in the quality of Physics learning. Consequently, there is an imperative need for instructional media that can transform traditional Physics classrooms into dynamic learning environments.

As a solution, the development of interactive, technology-based learning media is proposed. Such media can increase student interest, motivation, and attention (Rahmi et al., 2020; Sari & Sutikno, 2024). Interactivity in media aids conceptual understanding through visualization and contextualization support, and facilitates active dialogue between students and educators (Cairncross & Mannion, 2001; Latumahina et al., 2023). Web-based media, such as those developed using Google Sites, are a strategic choice because they can integrate various multimedia elements (text, images, video, graphics) and are easily accessible through various devices (Fatonah & Isdaryanti, 2024; Hidayati et al., 2020; Indraloka et al., 2025). This platform is also known for being user-friendly, free, and flexible (Danin & Kamaludin, 2023; Kurniawan et al., 2024). Previous research has proven the effectiveness of Google Sites in increasing student enthusiasm and learning outcomes (Hermawati & Yulianto, 2025; Khairunnisa et al., 2024; Ningsih & Haryanto, 2025). These characteristics make it an ideal platform for developing accessible and engaging learning resources.

This research does not merely adopt Google Sites but introduces novelty in its development. The media is designed based on connectivism learning theory, realized through features such as discussion forums and chatbots to facilitate information access and build learning networks. Furthermore, the media is designed considering the diversity of student learning styles by providing content in various formats (text, interactive video, songs, virtual experiments, worksheets, and educational games). The development also adheres to principles of good website design (usability, navigation, visualization, and content quality) according to Powel A, (2022) and Saad (2020). This comprehensive approach ensures the developed media is both theoretically grounded and pedagogically sound.

Based on this explanation, this study aims to develop a valid, practical, and effective Google Sites-based interactive learning media for Physics instruction. By integrating the principles of connectivism and diverse learning styles, this media is expected to be an innovative solution for increasing student engagement and learning outcomes, while also addressing the challenges of learning in the Society 5.0 Era. The successful implementation of this media could serve as a model for technology integration in science education more broadly.

Method

This study employed a Research and Development (R&D) approach utilizing the 4D model. The research subjects were students of SMAN 1 Panti, Pasaman Regency, while the research object was a Google Sites-based interactive learning media. The sampling technique in this study used purposive sampling because researchers chose subjects based on certain criteria that were in accordance with the objectives of media development.

Following Thiagarajan et al. (1974), the 4D development model consists of four phases. First phase is define. The initial stage involved front-end analysis to identify problems in the physics learning process. Data were collected through classroom observations using an observation checklist and semi-structured interviews with teachers and students. The obtained data were analyzed to map the fundamental issues in physics instruction. Subsequent analyses included: (a) learner analysis concerning academic capabilities, social aspects, needs analysis, and student characteristics using questionnaires; (b) task analysis to identify competencies required according to students' developmental levels; (c) concept analysis to determine core concepts based on curriculum learning objectives; and (d) formulation of specific instructional objectives.

The second phase is design. This phase commenced with the construction of criterion-referenced tests using multiple-choice items. The test instruments underwent preliminary validation through item analysis measuring discrimination index, difficulty level, validity, and reliability. Subsequently, media and format selection were conducted based on technical considerations and learning needs. The next step involved drafting the initial prototype of the learning media using Google

Sites, consistent with the previously determined media and format selection.

The third phase is development. The development phase began with expert validation using a Likert-scale (1-5) questionnaire covering media, content, and linguistic aspects. The validation instrument was first reviewed by evaluation experts, with validity measured using Aiken's V formula. Media validity was analyzed through percentage descriptive analysis. The product was revised based on expert feedback, followed by developmental testing to examine practicality. Practicality data were collected through validated questionnaires administered to teachers and students, analyzed using percentage descriptive analysis.

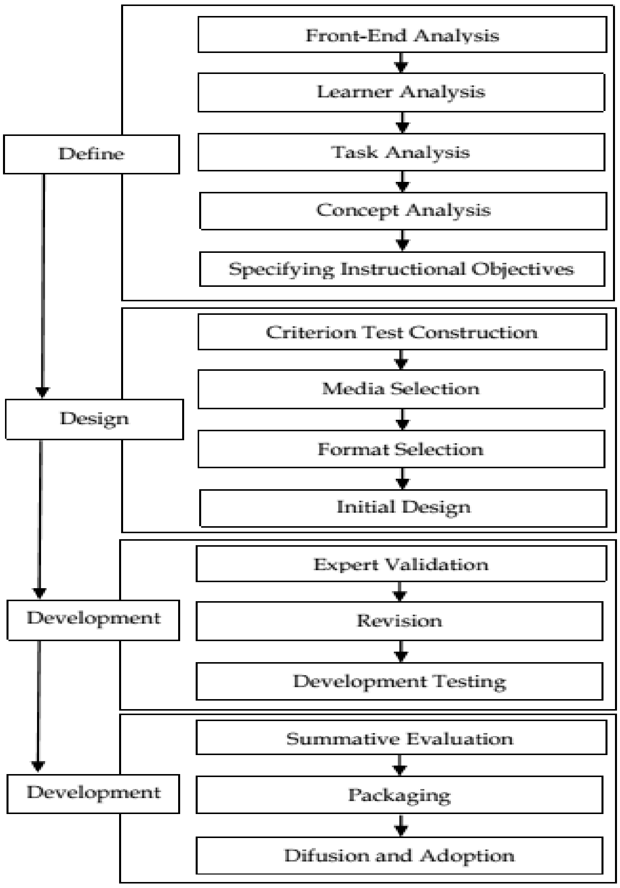

Figure 1. 4D model development

The fourth phase is disseminate. The final stage involved summative evaluation after a four-session implementation period. Effectiveness was measured using validated multiple-choice tests analyzed with normalized gain (N-Gain) scores. The finalized product was packaged, and diffusion to physics teachers, with dissemination data collected through validated questionnaires and analyzed using percentage descriptive analysis. In summary, Figure 1 illustrates the implementation flow of the 4D development model in this research.

Result and Discussion

The research results can be described as follows:

Define

At this stage, problems were found in the Physics learning process, namely low motivation and active participation of learners, easily distracted concentration, difficulty understanding the material and utilization of technology in the learning process less than optimal. Analysis of learner characteristics showed that only 9.68% of learners were in the advanced category. Learners have diverse learning styles and are accustomed to using mobile phones connected to the internet. The results of the task and concept analysis show that based on the applicable curriculum, one of the competencies that learners need to master is conceptual understanding and process skills in analyzing the relationship between force and motion of objects with one of the main materials on the concept of material elasticity. The results of the concept and task analysis are used as the basis for formulating learning objectives.

Design

The first step was to develop test standards. The test standards used were expert-validated instruments for validity, practicality, performance assessment, and effectiveness, as well as statistically tested multiple-choice tests. The results of the expert validation of the instruments are shown in Table 1.

Table 1. Instrument Validation Results

Validation Aspect	Score	Category
Clarity	0.92	Very high validity
Accuracy of content	0.75	high validity
Relevance	0.75	high validity
Validity of content	0.88	Very high validity
Language	0.75	Very high validity

Meanwhile, the results of the analysis of the multiple choice test questions can be seen in Table 2.

Table 2. Results of Trial Question Analysis

Aspect	Category	Amount
Differential power	Bad	2
	Enough	4
	Good	2
	Very good	22
Level of difficulty	Easy	6
	Currently	21
	Difficult	3
Validity	Valid	22
	Invalid	8
Reliability		0.74 (Reliable)

Based on the analysis results in Table 7, 20 questions were selected that met the valid category, had very good discrimination power and varying levels of difficulty.

The next step is media selection, which takes into account learner characteristics, including learning styles, task analysis results, and learning concepts and objectives. The chosen format is a website using Google Sites because it is easy to use, free, flexible, and can be integrated with various media to support the learning process.

Next, designed interactive learning media based on Google Sites. The initial design can be seen in Figure 2.

Figure 2. Initial media design

The systematics of the initial design of the learning materials can be seen in Figure 2.

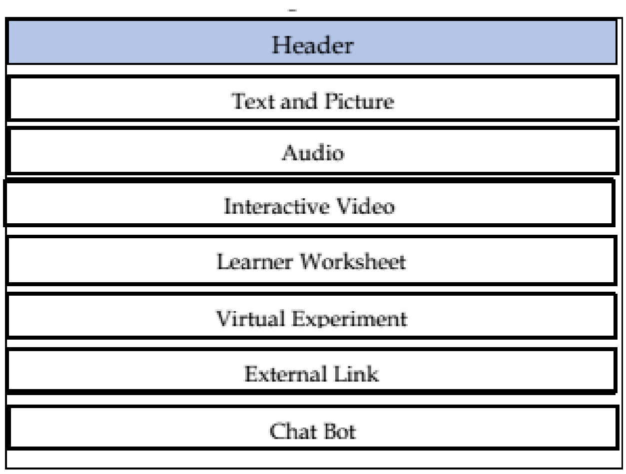

Figure 3. Systematics of the initial material design

Figures 1 and 2 shown that the interactive learning media based on Google Sites has 7 main menu, homepage, instructions, learning objectives, learning materials, educational games, evaluations and discussion forums, and the material section is equipped with various media according to the characteristics of the learners.

Development

The first step is expert validation, consisting of media, materials, and language experts. The validation results according to the experts can be seen in Table 3.

Table 3. Media Validation Results by Experts

Validation Type	Percentage (%)	Category
Media Expert	90.71	Very High Validity
Subject Matter Expert	91.72	Very High Validity
Linguist	90.59	Very High Validity
Average	91.01	Very High Validity

After being validated by experts, the interactive learning media was revised. The revised elements are shown in Table 4.

Table 4. Media Revisions According to Experts

Aspect	Revision
Media	The menu color needs to be made contrasting, the menu should be given a certain symbol and the website name should be made larger.
Material	Create vector notation for vector quantities, italicize foreign text, add images and use vibrant colors and use different colors for each icon.
Language	Correct your use of letters, fix spelling errors and pay attention to the use of punctuation.

Next, a development trial was conducted. Based on the trial results, educators and learners responded to the practicality and effectiveness of the learning media. The results regarding the practicality of the media are shown in Table 5.

Table 5. Media Practicality Results

Aspect	% of education	% of learners	category
Ease of use	90.00	93.33	Very practical
Time efficiency	90.00	91.33	Very practical
Benefit	90.00	92.10	Very practical
Website	92.60	92.17	Very practical
Usability	87.50	91.67	Very practical
Navigation	92.60	91.83	Very practical
Visual design	92.60	92.00	Very practical
User experience	87.60	91.00	Very practical
content	85.00	90.67	Very practical
Media interactivity	87.60	90.67	Very practical
Average	89.50	91.68	Very practical

The results of the pre-test and post-test conducted on the knowledge and skills aspects obtained data as shown in Table 6.

Table 6. N-Gain Test Results

Aspect	N	Pretest Average	Posttest Average	N Gain Score	Category
Knowledge	30	19.67	80.33	0.76	High
Skills	30	40.21	84.43	0.73	High

The effectiveness of interactive learning media based on Google Sites can also be seen from the responses of educators and learners with the results in Table 7.

Table 7. Response Results on Media Effectiveness

Aspect	Percentage of education (%)	Percentage of learners (%)	category
Motivation to learn	83.40	84.67	Very high
Learner Focus	90	88.44	Very high
Learner involvement	96.60	83.56	Very high
Understanding the Material	93.40	85.84	Very high
Enthusiasm of Learners	96.60	84.49	Very high
Internet optimization	90	86.67	Very high
Electronic device optimization	93.40	84.00	Very high
Average	92.38	85.38	Very high

Disseminate

The first step taken at this stage is a summative evaluation to determine whether the development objectives have been achieved. The results of the summative evaluation of the media development conducted are shown in Table 8.

Table 8. Summative Evaluation Results

Objective	Aspect	% Achievement	Category
Media Validity	Media	90.71	Very Worthy
	Material	91.43	Very Worthy
	Language	91.50	Very Worthy
Media Practicality	Educator	88.11	Very Practical
	Learners	91.68	Very Practical
Media Effectiveness	Knowledge	0.7660	High
	Skills	0.7386	Tall
	Media	90.29	Very high

Figure 4. Barcode of interactive learning media based on google sites

Next, the final packaging of the media is carried out in the form of a barcode as seen in Figure 4. The final step was to disseminate the media, which had been stated valid, practical, and effective, to other Physics educators. Educator responses can be seen in Table 9.

Table 9. Physics Educators' Responses to Media

Origin of Educator	% Achievement	Category
SMAN 1 Mapat Tunggul	96.00	Very good
SMAN 1 Mapat, Tunggul Selatan	96.89	Very good
SMAN 1 Padang Gelugur	93.78	Very good
SMAN 1 Panti	88.00	Very good
SMAN 1 Rao Utara	97.33	Very good

Discussion

This study demonstrates that the Google Sites-based interactive learning medium effectively supports physics education through its integrated multimedia approach. The high validity scores across media, content, and linguistic aspects reflect the medium's strong theoretical foundation, particularly its alignment with connectivism principles that emphasize networked learning. These findings corroborate previous research by Danin et al. (2023) and Hermawati et al. (2025) regarding the viability of Google Sites as an educational platform, while extending their work through specific pedagogical applications in physics education.

The medium's effectiveness stems from its multimodal design that accommodates diverse learning preferences. The combination of interactive videos, virtual experiments, and educational games provides multiple pathways for concept mastery, supporting cognitive load theory through complementary information channels. This explains the significant improvement in learning outcomes, consistent with Hidayati et al. (2020) findings on multimedia learning effectiveness.

The chatbot feature emerged as a particularly impactful component, serving as an accessible alternative to human-mediated support. Analysis of usage patterns revealed that students frequently utilized the chatbot for immediate clarification of concepts and guidance through learning materials. This finding aligns with Kuhail et al. (2023) research on AI in education, suggesting that structured digital assistance can effectively supplement traditional teacher-student interactions. The chatbot's 24/7 availability addressed individual learning needs promptly, contributing to the medium's high practicality ratings from both educators and students.

However, the discussion forum implementation revealed important contextual limitations. Despite strategic design to foster collaborative learning, analysis of participation data showed underutilization of this feature. Student feedback indicated reluctance stemmed from social concerns about peer judgment and cultural factors affecting academic discourse. This phenomenon mirrors Sibia et al. (2023) findings regarding student hesitancy in public academic platforms. Interestingly, the chatbot's effectiveness may have inadvertently reduced forum participation by providing an alternative, more private help-seeking channel.

The complementary relationship between chatbot and discussion forum features offers valuable insights for educational technology design. While the chatbot successfully addressed immediate, individual learning needs, the forum's potential for collaborative knowledge construction remained underutilized. This suggests that merely providing collaborative tools is insufficient without structured facilitation and cultural adaptation. Future implementations could benefit from integrating chatbot interactions that encourage subsequent forum participation or developing phased approaches to build student comfort with public academic discourse.

These findings contribute to understanding how different communication modalities function within integrated learning platforms. The study highlights the need for balanced implementation strategies that address both individual learning support and collaborative knowledge building, while considering contextual social dynamics in educational technology adoption.

Conclusion

This study demonstrates that the developed Google Sites-based interactive learning media meets the criteria for educational implementation. Expert validation confirms the media's in content, design, and linguistic aspects very high validity, while user feedback indicates its practical applicability in classroom settings. The improvement in learning outcomes, as measured through knowledge and skills assessments, supports the media's potential effectiveness in physics education. These findings suggest that thoughtfully designed digital platforms can serve as valuable supplements to conventional physics instruction. The study contributes to technology-enhanced learning literature by documenting the development process of an accessible web-based tool. Future research could investigate the media's application across different educational contexts and its long-term impact on student engagement.

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Author Contributions
The primary author, Ulil Kurnia, makes contributions to product development, research design, research execution, data collection, and writing research articles. Ulfia Rahmi, second and corresponding author, was a supervisor in research activities ranging from article writing, reviews, to editing. Meanwhile, the third and fourth authors played a role in reviewing the initial manuscript and providing input.

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

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