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Empowering Science Education with Google Sites: Development and Evaluation of Differentiated Learning Media for Middle School Using the ADDIE Model

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Abstract

Background: The rapid advancement of digital technology and the implementation of the Merdeka Curriculum in Indonesia have highlighted the need for differentiated learning to address the diverse needs of students. However, many classrooms still employ uniform teaching methods, which often fail to accommodate individual learning styles—particularly in science education.
Aims: This study aimed to develop and evaluate differentiated learning media supported by Google Sites for the science topic "Classification of Living Things", tailored to students' visual, auditory, and kinesthetic learning preferences.
Methods: The research adopted the ADDIE development model (Analysis, Design, Development, Implementation, Evaluation). Expert validation was conducted by specialists in content, media, and instructional design. The media was tested in three phases: individual, small-group, and field testing. Effectiveness was assessed by comparing the pretest and posttest scores between the experimental group and the control group using parametric statistical tests.
Results: The developed media was rated as "Very Feasible" by experts, with average validation scores exceeding 89%. User testing also yielded highly positive feedback, with an average feasibility score of 88%. The experimental group achieved significantly higher post-test scores than the control group ($p < 0.05$), and the normalized gain score of 0.46 indicated moderate effectiveness.
Conclusion: Differentiated learning media supported by Google Sites is a feasible and effective tool for enhancing student learning outcomes in science education. Its integration supports personalized learning and aligns with the national curriculum reforms that emphasize student-centered instruction.

A. Introduction

Education plays a crucial role in fostering the holistic development of individuals—cognitively, affectively, and psychomotorically, enabling them to become competent and adaptive members of society (Sebu, 2023). Globally, educational systems are increasingly embracing approaches that accommodate learner diversity (Gruzdeva et al., 2020). This shift is particularly relevant in the 21st century, which demands learning that is personalized, active, and contextually meaningful. In Indonesia, these principles are reflected in the implementation of the Merdeka Curriculum, which promotes "freedom to learn" by granting autonomy to schools, teachers, and students to design innovative, student-centered educational experiences (Arafat et al., 2025).

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However, the implementation of the Merdeka Curriculum still faces various challenges, particularly in classroom settings (Jannah et al., 2022; Sibuea et al., 2023). Observations at SMP Dharma Bakti Lubuk Pakam, a multicultural private junior high school in North Sumatra, indicate that science instruction continues to rely on conventional teaching methods, primarily lectures, with uniform learning materials that do not account for individual learner differences. This school, which serves students from diverse ethnic, cultural, and religious backgrounds, has yet to fully realize the differentiated learning approaches mandated by the new curriculum. Consequently, students' academic achievements in science remain stagnant, with most performance indicators falling within the average range, barely meeting the Minimum Mastery Criteria.

Data from the past two academic years show that the majority of students score between 70 and 79 on daily assessments—a result that, while technically acceptable, reveals no substantial improvement. Interviews with science teachers confirm that instructional design remains uniform and still lacks differentiation despite the curriculum's learner-centered intentions. Diagnostic assessments conducted by the researcher revealed that the majority of students possess a visual learning style (51.56%), followed by kinesthetic (39.06%), and only a small percentage are auditory learners (9.37%). These findings underscore the urgent need for teaching strategies and media that reflect and address the diverse learning preferences of students.

Differentiated instruction offers a promising solution to these challenges (Yavuz, 2020). Tomlinson, in Suryati et al. (2023) advocates for teaching approaches that adjust content, processes, and products to meet learners' readiness, interests, and learning profiles. This perspective is aligned with the educational philosophy of Ki Hajar Dewantara, Indonesia's first Minister of Education, who emphasized the importance of respecting each student's unique nature (Pranajaya et al., 2022). Implementing differentiation effectively requires flexible groupings, ongoing assessment, and varied instructional media tailored to multiple intelligences and learning preferences (Iryani et al., 2023).

In the digital age, the integration of information technology has become essential in supporting differentiated learning (Rahayu & Rosti, 2023). Google Sites is one such platform that holds significant potential for enabling this approach (Afifah et al., 2021; Setiawan et al., 2022). However, most previous studies that employed Google Sites have primarily focused on its functionality as a tool for organizing and presenting learning materials (Sorongan & Fauji, 2023). For instance, several studies highlighted its ease of use and integration for project-based learning or e-portfolios, but they did not thoroughly examine its effectiveness in promoting deeper student engagement or critical thinking in vocational education contexts. This indicates a gap in the literature particularly regarding the pedagogical impact of Google Sites when applied in technical and vocational learning environments.

Google Sites allows teachers to design personalized, multimedia-rich instructional websites that include text, images, videos, audio, and interactive links (Wicaksono et al., 2023). The platform is free, user-friendly, supports collaborative work, and offers online storage (Ernest & Putra M, 2023). Previous research, such as that conducted by Yanto et al. (2023), has demonstrated that Google Sites-based instructional media are well received and considered appropriate by both students and teachers. However, these studies often fall short of aligning media design with students' specific learning needs and styles.

This study seeks to bridge that gap by developing a differentiated instructional media platform using Google Sites, grounded in diagnostic assessments of student's learning styles. The goal is to design not merely to design a multimedia learning resource, but to create a tailored educational experience that effectively supports the diverse needs of learners. The research aims to examine the feasibility and effectiveness of this differentiated media in enhancing science learning outcomes for Grade VII students at SMP Dharma Bakti Lubuk Pakam. In doing so, it contributes both theoretically and practically to the implementation of learner-centered, adaptive teaching methods within the framework of the Merdeka Curriculum.

B. Research Methods

This study employed a Research and Development (R&D) approach using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation) as a framework to develop and evaluate differentiated learning media through Google Sites (Larson & Lockee, 2019; Sibuea et al., 2021). The following is a presentation of the phases for the Addie model which is presented in Figure 1 below.

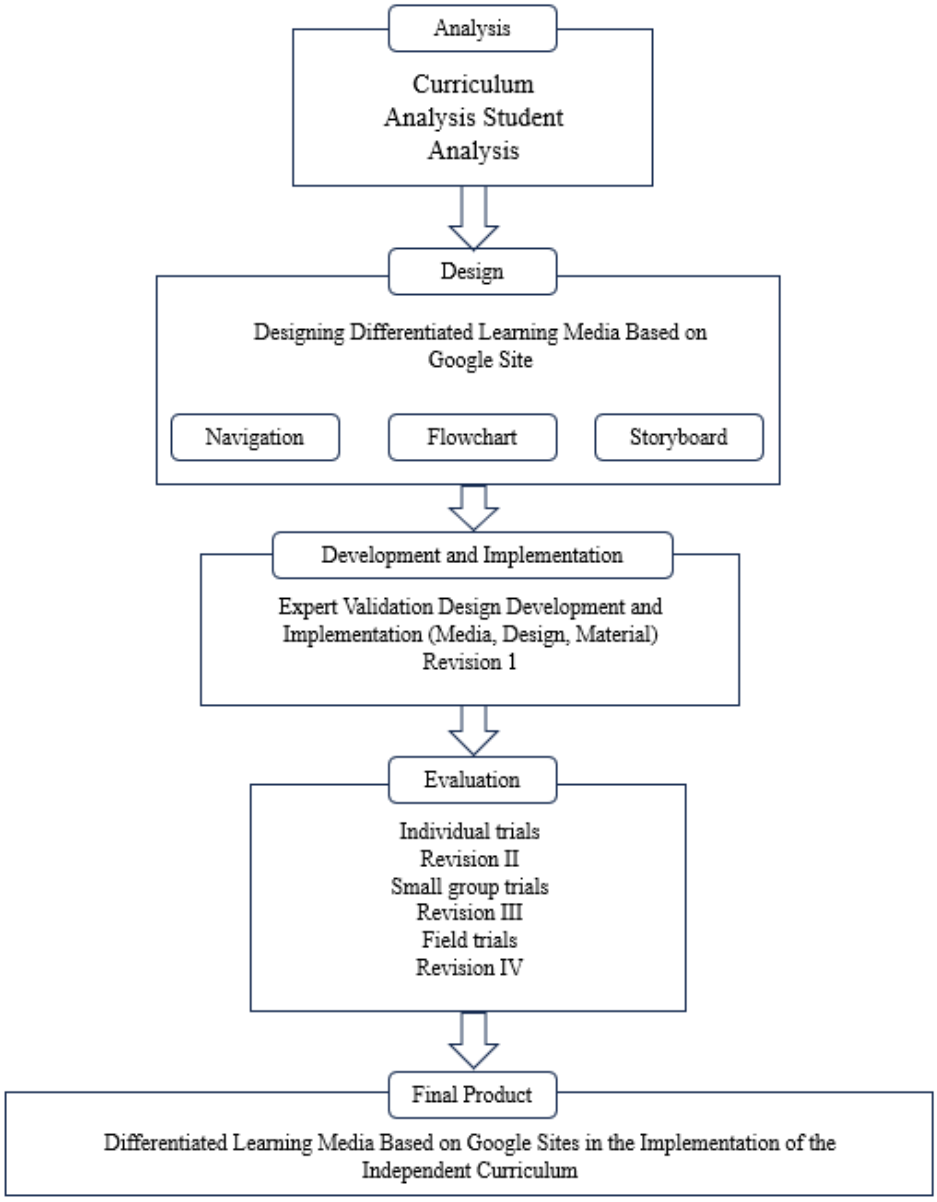

Figure 1. Phase ADDIE Model

The goal of this study was to design and implement an effective and appropriate instructional media platform tailored to various student learning styles in the context of the Indonesian Merdeka Curriculum. The research was conducted at SMP Dharma Bakti Lubuk Pakam. The population of the study consisted of all seventh-grade students at the school, and the research was carried out from January to March 2025. A cluster random sampling technique was employed to select two intact classes from the population of Grade VII students. This method was chosen because the school assigns students to pre-existing classes, making it impractical to randomly assign individuals. By randomly selecting from these naturally occurring clusters (classes), the study maintained practical feasibility while minimizing selection bias. Class VII-1 was designated as the control group, and Class VII-2 served as the experimental group. This approach ensured representativeness by giving each class an equal chance of being selected, thus supporting the generalizability of the findings within the school context. The focus of the study was the science topic "Classification of Living Things".

The research procedures followed the five phases of the ADDIE model (Larson & Lockee, 2019). In the Analysis phase, the researcher conducted a qualitative needs assessment through classroom observations and semi-structured interviews with two science teachers. The observations focused on identifying student engagement, teaching methods, and the use of instructional media in the classroom. Meanwhile,

the interviews explored the challenges faced by teachers in addressing students' diverse learning styles and the limitations of existing teaching resources. Questions included topics such as, "What difficulties do students face in understanding the topic of Classification of Living Things?" and "What types of media or strategies have you found effective or lacking in current practice?" The data collected revealed that students had varying levels of understanding due to differences in learning preferences, and that current instructional methods were heavily lecture-based. These findings informed the design of differentiated media tailored to students' learning needs.

In the Design phase, learning objectives were aligned with the Merdeka Curriculum, and instructional materials were structured based on different learning styles. During the Development phase, the instructional content and interface were created using Google Sites and subsequently underwent a structured expert validation process. Three types of experts were involved: an instructional design specialist, a media expert, and a science subject-matter expert. Each expert was provided with a validation instrument in the form of a structured questionnaire using a Likert scale accompanied by open-ended feedback sections. The instrument assessed several criteria, including content accuracy, instructional clarity, media quality (layout, navigation, and visuals), alignment with learning objectives, and suitability for students' learning styles. Experts rated each aspect on a scale from 1 (very poor) to 5 (very good). Qualitative suggestions were also collected to improve specific components of the media. The researcher analyzed the quantitative results by calculating the average scores for each criterion, categorizing the product as "very feasible" overall. Feedback from the experts was then integrated iteratively—content inaccuracies were revised, visual design was improved for better usability, and instructional strategies were refined to better match student learning styles. This ensured that the final product met both pedagogical standards and technical usability for classroom implementation.

During the Implementation phase, the Google Sites-based media was used in the experimental group over a period of six weeks, with learning sessions lasting approximately 40 minutes each. In these sessions, the teacher acted as a facilitator, guiding students through the differentiated instructional materials while encouraging independent exploration based on their individual learning styles. Students interacted actively with the media by accessing multimedia content such as videos, quizzes, and interactive activities tailored to visual, auditory, and kinesthetic learners. The teacher monitored student progress, provided assistance as needed, and fostered collaborative discussions to deepen understanding.

In the Evaluation phase, feedback on the media's practicality and student engagement was collected using structured student questionnaires and teacher observation checklists administered during the learning sessions. The pretest was conducted before the introduction of the Google Sites media to establish baseline knowledge on the topic of "Classification of Living Things". After completing the instructional period, a post-test with similar difficulty and format was administered to measure learning gains. Both tests consisted of multiple-choice and short-answer questions aligned with the learning objectives. Test scores were recorded and analyzed statistically to determine the significance of learning improvement. All data, including questionnaire responses and observation notes, were systematically collected and used to evaluate both the effectiveness and usability of the instructional media.

The data collection techniques used in this study were observation, interviews, questionnaires, and documentation. Observations were made during trial sessions to monitor students' interaction with the media. Interviews were conducted with teachers and students to gather qualitative insights. Questionnaires were used to collect responses from experts, teachers, and students regarding the media's usability and relevance. Documentation of class activities supported the validity of the data collected.

The research instruments included structured interview guides, observation checklists, response questionnaires, and learning outcome tests. Questionnaires for media experts assessed instructional design, presentation, and interface quality. Student questionnaires evaluated content clarity, navigation ease, and engagement. The learning outcome test consisted of multiple-choice questions addressing Bloom's taxonomy levels from C1 (Remembering) to C6 (Creating), focusing on the topic "Classification of Living Things".

For the analysis plan, data validity and reliability were confirmed through preliminary trials. Descriptive statistics were used to summarize response data. The effectiveness of the developed media was assessed using pretest and post-test scores. A Kolmogorov–Smirnov test was applied to verify data normality, and Levene's test was used to check homogeneity. Additionally, the normalized gain score (g), as proposed by Hake in Isnaniah & Imamuddin (2020), was calculated to evaluate the magnitude of learning improvement. This study had several limitations. First, the implementation was confined to one topic

within the science curriculum, which may limit the generalizability of the findings to other subjects. Second, the sample size was restricted to one school with two classes, limiting the scope of external validity. Finally, while the learning media was tailored based on learning styles, other learner characteristics such as prior knowledge or motivation were not deeply examined.

C. Results and Discussion

1. Results

1.1 Development Process of the Learning Media

The product of this study was a differentiated learning media developed using Google Sites for the science topic “Classification of Living Things”. The development followed the ADDIE model, consisting of five phases: Analysis, Design, Development, Implementation, and Evaluation.

In the Analysis phase, a needs assessment was conducted involving 32 students and 2 science teachers at SMP Dharma Bakti Lubuk Pakam. The results revealed that 100% of respondents reported a need for differentiated learning media supported by Google Sites. All students owned smartphones and were familiar with their use, yet classroom instruction remained teacher-centered and lacked differentiated approaches.

In the Design phase, the media was structured to include diverse content formats text, audio, video, and interactive activities tailored to students’ learning styles (visual, auditory, kinesthetic). The Google Sites layout featured a homepage, instructions, learning objectives, materials, videos, evaluation, and teacher profile sections. The Development phase involved constructing the media platform, validating it through three experts (content, media, and instructional design), and conducting three levels of user testing: individual, small-group, and field testing.

1.2 Expert Validation Results

Three experts—one in content, one in media, and one in instructional design—validated the product. All rated the media as "Very Feasible" for classroom use.

Table 1. Expert Validation Summary

No	Expert Type	Average Score (%)	Feasibility Category
1	Content Expert	92%	Very Feasible
2	Media Expert	89.5%	Very Feasible
3	Instructional Design Expert	95%	Very Feasible
	Overall Average	92%	Very Feasible

The slight differences in scores between the individual, small-group, and field tests were primarily influenced by the context and interaction patterns at each stage. In the individual test, the average score was 83%, which may be due to students interacting with the media independently, without peer assistance or discussion. This condition could lead to initial confusion or slower adaptation to the media interface. Feedback from this stage often related to the clarity of navigation and the need for more intuitive instructions.

During the small-group test, the average score increased to 90%. This improvement can be attributed to the presence of collaborative learning, where students were able to exchange ideas and support each other in understanding the content. At this stage, feedback was more focused on the pacing of the media and suggestions for enhancing interactive elements that support group activities.

In the field testing phase, with a larger group of 31 students in a real classroom environment, the average score slightly declined to 87%. This decrease may reflect the influence of varied student backgrounds, different levels of prior knowledge, and classroom management factors. However, the score still indicated strong feasibility. Feedback from this phase was more comprehensive, including suggestions for better integration into the curriculum and recommendations to adapt the media for broader classroom use. Each stage provided unique and valuable insights that contributed to the refinement of the learning media to ensure its overall effectiveness and feasibility.

1.3 User Testing Results

Usability testing was conducted at three levels: Individual, Small-Group, and classroom-wide Field Testing.

Table 2. User Testing Summary

No	Test Type	Participants	Average Score (%)	Feasibility Category
1	Individual	3 students	83%	Very Feasible
2	Small-Group	9 students	90%	Very Feasible
3	Field Testing	31 students	87%	Very Feasible
	Overall Average		88%	Very Feasible

The results show high feasibility across all testing levels. Suggestions from students were mostly related to improving the clarity of instructions within the media.

1.4 Student Learning Outcome Results

Pretest and post-test assessments were used to compare learning outcomes between the Control group (traditional media) and the Experimental group (Google Sites media).

Table 3. Descriptive Statistics – Post-test Scores

Group	N	Min	Max	Mean	Median	Mode	Std. Dev
Experimental	31	61	97	77.32	74.00	74	8.90
Control	33	34	88	60.12	59.00	56	15.15

The Experimental group achieved a higher mean score with a smaller standard deviation, indicating better and more consistent learning outcomes than the Control group.

Table 4. Normality Test (Shapiro-Wilk)

Data Type	Group	Sig. Value	Conclusion
Pre-test	Experimental	0.740	Normal
Pre-test	Control	0.806	Normal
Post-test	Experimental	0.272	Normal
Post-test	Control	0.456	Normal

All data sets meet the assumption of normality, allowing for the use of parametric tests.

Table 5. Homogeneity Test (Levene's Test)

Test	Sig. Value	Conclusion
Post-test	0.378	Homogeneous

These results confirm that the data meet the assumption of homogeneity of variances (Sig. = 0.378 > 0.05), meaning that the variances between groups are statistically equal. Therefore, it is appropriate to proceed with parametric tests such as the independent samples t-test for further comparative analysis.

Table 6. Independent Samples T-Test

Group	N	Mean	Std. Dev	Sig. (2-tailed)	Conclusion
Control	33	17.20	3.13	0.000	Significant difference
Experimental	31	17.20	3.08		

The p-value (0.000) from the independent samples t-test indicates a statistically significant difference in post-test scores between the control and experimental groups at the 0.05 significance level. This strongly supports the research hypothesis that using Google Sites as a learning medium has a significant positive effect on student learning outcomes. Although the mean scores appear numerically similar in the table, the statistical test confirms that the distribution of scores in the experimental group differs in a way that is unlikely to have occurred by chance, validating the effectiveness of the intervention.

Furthermore, the slight difference in standard deviations between the control group (3.13) and the experimental group (3.08) does not violate the assumption of homogeneity of variances. This is supported by the result of Levene's Test (Sig. = 0.378), which shows that the variances are statistically equal ($p > 0.05$). Thus, it is appropriate to use a parametric test such as the t-test, and the results can be interpreted with confidence.

Table 7. N-Gain Score – Experimental Group

Min Gain (%)	Max Gain (%)	Average N-Gain	Category	Effectiveness
11%	95%	0.46	Moderate	Moderately Effective

The normalized gain score demonstrates a moderate level of learning improvement, showing that the media was effective in enhancing students' conceptual understanding.

2. Discussion

The findings of this study indicate that the use of Google Sites as a learning medium effectively improved student learning outcomes. This result aligns with constructivist learning theory, which emphasizes the importance of learner-centered environments and the active construction of knowledge. Google Sites facilitates this by enabling multimedia integration, interactive elements, and flexible access, allowing students to learn according to their individual learning styles visual, auditory, and kinesthetic.

This outcome is also consistent with previous studies that employed digital or differentiated instruction. For example, Sobodić et al. (2022) and Valadas et al. (2022) found that interactive digital platforms contribute significantly to improving student engagement and achievement, particularly in science education. The relatively low standard deviation observed in the experimental group suggests a more consistent level of performance, which may result from the personalized and accessible nature of the learning media. In addition, Google Sites supports the principles of the Merdeka Curriculum by promoting independent learning, student agency, and integration of technology in the learning process. Its accessibility and familiarity among students further enhance its practicality and relevance in current educational settings. Overall, these results confirm that interactive and differentiated media like Google Sites can effectively enhance learning outcomes and support modern pedagogical approaches.

2.1. Implications

The findings of this study demonstrate that the integration of Google Sites into differentiated instruction significantly enhances student learning outcomes in science education, particularly in the topic of Classification of Living Things. The experimental group not only achieved higher post-test scores but also displayed more consistent performance, as indicated by a lower standard deviation. These results suggest that media tailored to students' learning styles visual, auditory, and kinesthetic offers a more personalized and engaging learning experience. This implies that schools and educators should consider moving beyond traditional lecture methods and embrace technology-based differentiated instruction to meet diverse student needs, as encouraged by the Merdeka Curriculum in Indonesia. The study also emphasizes the value of using free and accessible platforms like Google Sites to support 21st-century learning. As many students already use smartphones and access the internet in daily life, leveraging these tools for educational purposes can create more relevant, interactive, and student-centered learning environments.

2.2. Research Contribution

This study contributes to the growing body of literature on technology-enhanced learning and differentiated instruction by developing and validating a practical media solution grounded in student learning style analysis. While previous studies have shown that Google Sites is a feasible platform for instructional delivery, this study extends prior work by focusing on media differentiation based on learner profiles, not just content availability. Furthermore, the research provides a structured application of the ADDIE model in a real classroom setting, combining expert validation, iterative testing, and statistical evaluation. The resulting instructional media can serve as a reference model for future innovations in science education and instructional design in Indonesia and beyond.

2.3. Limitations

Despite the promising outcomes, this study has several limitations. First, the research was limited to one topic in the science curriculum and conducted in a single school with a relatively small sample size. As such, generalizability to other subjects or educational contexts should be made cautiously. Second, while the media was customized based on student learning styles, other learner variables such as prior knowledge, motivation, or digital literacy were not thoroughly analyzed. This could affect how different students interact with or benefit from the media. Lastly, some teachers reported difficulties in guiding students through independent exploration using the media. This highlights an ongoing reliance among students on direct teacher instruction, suggesting that both students and teachers may need further training in utilizing digital platforms for self-directed learning.

2.4. Suggestions

Future studies should explore the use of Google Sites-based differentiated media across different subjects and grade levels to enhance the generalizability of findings. It is also recommended to incorporate other

learner characteristics, such as motivation, learning readiness, or prior knowledge, to create even more effective personalized learning experiences. For practitioners, training in instructional technology integration is crucial. Schools should support teachers with professional development programs that enhance their skills in digital pedagogy, particularly in designing and facilitating differentiated instruction using online platforms. Lastly, future research could investigate the long-term impact of differentiated digital media on student learning retention, motivation, and independent learning habits, which are essential for lifelong learning.

D. Conclusion

This study aimed to develop and evaluate a differentiated learning media using Google Sites for Grade VII science instruction, specifically the topic of "Classification of Living Things". The evaluation results highlight three key findings. First, in terms of media feasibility, expert validators in content, media, and instructional design rated the product as very feasible for classroom implementation. This validation was further supported by positive student responses during individual, small-group, and field trials, indicating that the media was easy to access, visually engaging, and functionally supportive of independent learning. These findings confirm that the media design met technical, pedagogical, and user-experience standards necessary for practical use in schools.

Second, regarding learning effectiveness, statistical analysis revealed a significant improvement in student learning outcomes in the experimental group compared to the control group using conventional methods. The normalized gain (N-gain) score of 0.46 falls within the "moderate" category, suggesting that the media contributed to meaningful conceptual gains. This improvement is attributed to the integration of students' learning styles visual, auditory, and kinesthetic into the design of the media, which provided a more personalized and engaging learning experience than traditional lecture-based instruction.

Third, the media aligns well with the principles of the Merdeka Curriculum, which emphasizes differentiated instruction, independent learning, and the meaningful integration of technology. By using a free and accessible platform like Google Sites, the media supports 21st-century learning objectives, allowing students to explore content at their own pace and in ways that suit their individual preferences. This approach empowers learners to take a more active role in the learning process, a core value promoted by the Merdeka Curriculum. The use of differentiated learning media supported by Google Sites is not only technically and pedagogically feasible, but also effective in improving student engagement and achievement. Its alignment with current curriculum goals makes it a promising tool for addressing the diverse needs of learners in today's classrooms.

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F. Author Contribution Statement

EM designed the study, conducted the data collection and analysis, and drafted the manuscript. SS contributed to the conceptual framework, supervised the research process, and provided critical revisions. AJ assisted in the development of the learning media, contributed to data interpretation, and supported the final editing of the manuscript. All authors read and approved the final version of the manuscript.

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