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Development of Geography E-Modules Based on Project-Based Learning to Improve Senior High School Students' Learning Outcomes

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Abstract

Background: The integration of digital media with student-centered learning approaches is crucial for enhancing education quality in the 21st century. However, geography instruction at SMA Negeri 1 Babalan still predominantly relies on textbooks and lacks interactive learning resources. This limitation reduces student engagement and leads to less-than-optimal learning outcomes.
Aims: This study aimed to develop a valid, practical, and effective Geography E-Module based on the Project-Based Learning (PjBL) model for Grade X students. The module focused on the lithosphere topic and was designed to improve student learning outcomes.
Methods: The research employed the ADDIE development model, consisting of the stages of Analysis, Design, Development, Implementation, and Evaluation. Data collection involved expert validations, teacher and student questionnaires, and pre-test and post-test assessments. Quantitative data were analyzed using descriptive statistics, paired t-tests, and N-Gain calculations.
Result: The developed E-Module achieved high validation scores: 98% for content, 87% for media, and 86% for instructional design. The practicality rating reached 94.45%. A statistically significant improvement was found in the experimental group's learning outcomes compared to the control group ($t = 2.37 > t\text{-table} = 1.670$). The N-Gain score of 0.41 indicated a moderate level of effectiveness in enhancing student performance.
Conclusion: The Project-Based Learning-based Geography E-Module is valid, practical, and effective in supporting student-centered learning. It successfully enhances student engagement and learning outcomes, making it a valuable instructional resource for senior high school geography education.

A. Introduction

Education is a fundamental investment for the future of a nation, playing a central role in shaping intelligent, skillful, and morally upright individuals. In the 21st century, educational practices worldwide, including in Indonesia, are undergoing significant transformation due to rapid technological advancements (Dankyi et al., 2022; Gruzdeva et al., 2020). With the rise of the digital era and the increasing use of the internet, over 221 million users in Indonesia as of 2024, technology integration in education is not just a trend but a necessity (Gbadegeshin, 2019). In Indonesia, the Ministry of Education and Culture has responded to this shift by introducing the Merdeka Curriculum, which emphasizes student-centered learning and encourages educators to design innovative learning experiences that cater to students' diverse needs (Andriansyah et al., 2022; Sibuea et al., 2023). One such innovation is the development of digital teaching materials, such

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as e-modules, that align with contemporary educational challenges and opportunities (Martin & Betrus, 2020). E-modules offer flexibility, interactivity, and accessibility, making them ideal for enhancing learning outcomes in various contexts, especially in subjects like geography that require both conceptual understanding and real-world application (Sumarmi et al., 2021; Desnita et al., 2022).

SMA Negeri 1 Babalan, the implementation of the Merdeka Curriculum remains suboptimal. Field observations show that geography instruction is still largely conventional, teacher-centered, and lacks interactive digital content. Many teachers continue to rely solely on textbooks reviewed in this study for their content accuracy, language clarity, quality of images, and the relevance of assignments. The textbooks generally present accurate content but use formal and sometimes complex language that may be difficult for some students to fully understand. The images are mostly static and limited in number, reducing visual engagement.

Furthermore, assignments tend to be routine and do not encourage critical thinking or active student participation. These limitations contribute to students' declining interest and motivation in geography classes. These conditions have contributed to unsatisfactory learning outcomes. In the 2023/2024 academic year, more than 50% of students scored below the competency threshold of 75 in geography, indicating a significant gap between the curriculum's expectations and classroom realities. This gap can be attributed to several issues: the lack of varied and student-oriented teaching methods, limited availability of interactive learning materials, and insufficient integration of digital tools that reflect students' technological literacy. Moreover, many teachers have yet to fully embrace their role as facilitators of independent learning, a key principle of the Merdeka Curriculum.

Several studies have highlighted the potential of e-modules in addressing such challenges. Research by Wijayanto et al. (2023), Yenny et al. (2022), and Zuhria et al. (2023) found that e-modules are effective in enhancing student engagement and academic performance. These studies underscore the advantages of e-modules in supporting independent learning and providing multimedia-rich content tailored to students' needs. However, most existing studies do not specifically explore the integration of Project-Based Learning (PjBL) strategies within geography e-modules at the senior high school level, particularly in rural or underdeveloped school settings (Nuri et al., 2023; Suryati et al., 2023).

This study addresses that gap by developing a geography e-module using Flipbook software based on the Project-Based Learning model (Jafnihirda et al., 2023). The PjBL approach, which emphasizes problem-solving, collaboration, and the creation of tangible projects, aligns well with the competencies required in the Merdeka Curriculum and the constructivist learning theory that underpins it (Fitriana et al., 2022; Jalinus & Nabawi, 2019). By embedding PjBL in an e-module format, the research aims to create a more engaging, relevant, and effective learning experience for students. Thus, this research aims to develop a geography e-module based on Project-Based Learning that is valid, practical, and effective in improving student learning outcomes at SMA Negeri 1 Babalan. This innovation is expected to bridge the gap between policy and practice and contribute to Indonesia's broader discourse on digital and project-based education.

B. Research Methods

This study employed a research and development (R&D) method using the ADDIE model—Analysis, Design, Development, Implementation, and Evaluation—to develop a geography e-module based on Project-Based Learning (PjBL). The ADDIE model was chosen because it provides a systematic and flexible framework for instructional design, ensuring that the developed learning media is aligned with student needs, pedagogical goals, and effective evaluation strategies. Its structured phases allow for continuous improvement and validation throughout the development process, making it especially suitable for producing practical and effective educational products (Larson & Lockee, 2019; Muruganantham, 2015). The study combined qualitative and quantitative approaches to assess the feasibility, practicality, and effectiveness of the developed e-module. The research was conducted at SMA Negeri 1 Babalan, located in Langkat Regency, North Sumatra, Indonesia, from January to February 2025. The research subjects were students from Grade X (Fase E), specifically class X Fase E-5 as the experimental group (35 students) and class X Fase E-2 as the control group (36 students). The sampling technique used was cluster random sampling, with group selection guided by geography teachers' recommendations and class characteristics.

The research procedure followed the ADDIE development steps. The researcher examined curriculum requirements, student characteristics, and learning needs in the analysis phase. The design phase involved planning the structure, content, and multimedia features of the e-module. During development, the e-

module was created using Canva and Flipbook, integrating text, audio, visuals, videos, games, and quizzes to accommodate diverse learning styles. Including of these multimedia features is based on the theory of multiple intelligences and learning preferences, which suggests that students learn more effectively when information is presented through various sensory modalities.

Additionally, interactive elements such as games and quizzes are incorporated to increase student engagement and provide immediate feedback, supporting deeper understanding and retention of geographic concepts. The implementation stage consisted of field testing in three stages: limited trials, small group trials, and large-scale trials. Finally, the evaluation phase measured the effectiveness of the e-module through assessments and feedback. Data collection techniques included observation, interviews, questionnaires, validation sheets, and learning achievement tests. The research instruments were developed and validated by experts in instructional design, media, content, and geography teachers.

The data analysis used both descriptive and inferential statistics. Descriptive analysis measured validity, practicality, and effectiveness levels using Likert-scale scoring. Inferential analysis was applied to test the effectiveness of the e-module using pre-test and post-test results. An independent sample t-test was conducted to compare the learning outcomes between the experimental and control groups. Before conducting the t-test, prerequisite statistical tests were performed to ensure the validity of the analysis. The Kolmogorov-Smirnov test was used to assess the normality of the data distribution, confirming whether the scores in both groups followed a normal distribution a fundamental assumption of parametric tests.

Additionally, the F-test for homogeneity of variances was conducted to determine whether the variances between the two groups were equal. Both tests indicated that the data met the assumptions required for applying the t-test, allowing for a valid comparison of learning outcomes. Reliability and validity of the test instruments were confirmed using point biserial correlation and Kuder-Richardson 20 (KR-20) formulas. This study was limited to the cognitive domain of student learning outcomes and focused solely on the lithosphere topic in the geography curriculum. It was also restricted to applying the e-module within one public high school context. These limitations may affect the generalizability of the findings beyond similar contexts.

C. Results and Discussion

1. Results

The Geography E-Module was developed using the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. In the analysis stage, the needs of students and teachers were identified through observations, interviews, and questionnaires. It was found that geography instruction at SMA Negeri 1 Babalan was still conventional and lacked interactive media. In the design stage, a storyboard and the structure of the e-module were developed, including multimedia content such as videos, audio, interactive quizzes, and learning reflections. The module was created using Flipbook in the development stage and underwent expert validation for content, media, and design. The implementation stage involved trials at various scales—from individual users to full-class testing. Lastly, the evaluation stage included revisions based on validation feedback and testing the module's effectiveness in improving learning outcomes.

1.1. Expert Validation Results

To assess the feasibility of the developed module, validation was conducted by six experts across three domains: content, media, and instructional design. The following table summarizes the results of the expert validation.

Table 1. Summary of Expert Validation Results

Validator Type	Average Score (%)	Category
Content Experts	98%	Very Valid
Media Experts	87%	Very Valid
Design Experts	86%	Very Valid
Overall Average	91%	Very Valid

The results indicate that the module is considered highly valid and feasible for classroom use. All validators agreed that the module meets the standards of clarity, content relevance, and visual presentation.

1.2. Practicality Testing Results

To measure the practicality of the E-Module, trials were conducted at three levels: individual testing, small group testing, and full-class field testing. Additionally, geography teachers were involved in evaluating the usability and accessibility of the module. The following table presents the results of the practicality assessments.

Table 2. Practicality Scores from Teachers and Students

Type of Trial	Participants	Average Score (%)	Category
Teacher Validation	Geography Teacher	99.3%	Very Practical
Individual Trial	3 Students	95%	Very Practical
Small Group Trial	9 Students	89.8%	Very Practical
Field Trial	36 Students	93.7%	Very Practical

All practicality tests yielded scores above 89%, confirming that the E-Module is easy to use, beneficial for learning, and well-designed regarding navigation and presentation.

1.3. Learning Outcomes Comparison

To evaluate the effectiveness of the E-Module, student learning outcomes were compared between the experimental group (using the E-Module) and the control group (using textbooks). The table below presents descriptive statistics of both groups.

Table 3. Descriptive Statistics of Student Learning Outcomes

Group	N	Mean Score	Highest	Lowest	Std. Deviation
Experimental	35	85.83	100	60	10.05
Control	36	83.77	100	36	16.26

The experimental group achieved a slightly higher average score than the control group, with a lower standard deviation, indicating more consistent performance.

1.4. Normality and Homogeneity Tests

Before conducting hypothesis testing, the data were analyzed for normality and homogeneity to meet statistical assumptions. The results are shown in the tables below.

Table 4. Normality Test Results (Lilliefors)

Group	L_{count}	L_{table}	Conclusion
Experimental	0.0047	0.149	Normal Distribution
Control	0.0709	0.149	Normal Distribution

Table 5. Homogeneity Test (F-Test)

Compared Groups	F_{count}	F_{table}	Conclusion
Experimental-Control	2.617	4.139	Homogeneous

Both tests confirm that the data meet the assumptions for conducting a parametric t-test.

1.5. Hypothesis Testing Results

The following table presents the result of the independent sample t-test, conducted to determine whether the difference in learning outcomes between the two groups was statistically significant.

Table 6. Independent Sample t-test Result

Test Type	t_{count}	t_{table}	Conclusion
t-test (2-Tailed)	2.37	1.670	Significant Difference Exists

Since the t-value exceeds the critical value, the result indicates a significant difference in learning outcomes, supporting the effectiveness of the developed module.

2. Discussion

Developing and implementing of a Geography E-Module based on Project-Based Learning (PjBL) has shown promising results in enhancing the quality of learning at SMA Negeri 1 Babalan. The module, developed using the ADDIE model and Flipbook platform, received very high validation ratings from content, media, and instructional design experts. These results are consistent with previous studies that reported high expert validation scores when applying the ADDIE model to develop digital learning media (Martin & Betrus, 2020; Rawat et al., 2024). However, this study innovates by integrating the Flipbook platform with Project-Based Learning principles specifically tailored for senior high school geography, which has been less explored in prior research. This combination enhances interactivity and student engagement beyond what conventional digital modules offer. It also demonstrated practicality through multiple trials and showed statistically significant improvements in student learning outcomes compared to conventional learning methods. The validation results—averaging 91% across all expert assessments—indicate that the E-Module is well-structured, accessible, and aligned with curriculum objectives. Teacher and student feedback confirmed its ease of use and educational relevance. Despite a medium N-Gain score, the experimental group outperformed the control group significantly, supporting the conclusion that digital and project-based approaches offer advantages in engaging students and facilitating deeper learning. These results align with previous studies Wijayanto et al. (2023) and Untari et al. (2020), which emphasize the value of combining multimedia elements and constructivist models like PjBL in promoting independent learning and motivation. However, the modest N-Gain percentage suggests that while the module increases understanding, it may not yet fully maximize cognitive gains for all students, highlighting areas for further refinement and support in classroom application.

2.1. Implications

This study has meaningful implications for the educational process at multiple levels. For teachers, the E-Module offers a structured and accessible digital tool that facilitates more interactive instruction that is aligned with the *Merdeka Belajar* curriculum. Students benefit from personalized and engaging content that supports independent learning and encourages collaborative project work. At the institutional level, this development aligns with current educational reforms. It demonstrates how digital innovation can be integrated into standard school practices to meet diverse student needs in both online and in-class.

2.2. Research Contribution

From a scholarly perspective, this research contributes to the existing knowledge in educational technology and instructional design. It demonstrates the practical application of the ADDIE model in creating a subject-specific digital learning module that incorporates constructivist learning principles. Additionally, this study provides empirical evidence supporting the combination of multimedia elements and PjBL methods in improving student outcomes, especially in under-resourced educational contexts. These findings can be a reference for future research or module development in other subjects or educational levels.

2.3. Limitations

Despite its strengths, the study has some limitations that should be acknowledged. The research was conducted in a single school and focused only on the lithosphere topic within geography, which limits the generalizability of the results. The sample size was relatively small, and some variability in students' access to devices and internet connections may have influenced their engagement with the module. Additionally, some teachers expressed difficulty guiding students through the project-based components, suggesting that further support may be necessary for optimal implementation.

2.4. Suggestions

To enhance the impact of this study, several recommendations can be made. Future module versions should further refine their interactivity, accessibility, and integration of formative assessments. Professional development programs are needed to equip teachers with the necessary skills to effectively implement digital and project-based learning strategies. It is also recommended that the module be tested in various schools and across different geography topics to assess its broader applicability. Moreover, providing students with clear instructions and orientation sessions on navigating and benefiting from the module would further strengthen its effectiveness and usability.

D. Conclusion

This study aimed to develop and evaluate a Geography E-Module based on Project-Based Learning (PjBL) for Grade X students at SMA Negeri 1 Babalan. The research followed the ADDIE model and produced a digital learning product using Flipbook that integrates interactive features with PjBL strategies. The findings indicate that the developed E-Module is valid, practical, and effective. Expert validation results showed an average feasibility score of 91%, classifying the product as "very valid" regarding content, media, and instructional design. Practicality tests involving teachers and students consistently received high ratings, confirming the module's accessibility, usefulness, and clarity. Effectiveness testing revealed a statistically significant difference in student learning outcomes between the experimental group (using the E-Module) and the control group, indicating that the module positively impacted student achievement. Although the N-Gain score was moderate (0.41), the E-Module demonstrated its potential to enhance learning engagement and promote independent learning. Thus, it can be concluded that the PjBL-based Geography E-Module is a feasible and impactful tool to support 21st-century learning in Indonesian high schools, particularly in geography instruction.

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F. Author Contribution Statement

JBM designed the study, collected and analyzed the data, and wrote the initial manuscript draft. EN supervised the research process, provided methodological guidance, and contributed to the interpretation of findings. SS reviewed and revised the manuscript critically for important intellectual content and ensured the accuracy and consistency of the final version. All authors approved the final manuscript.

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